Hunter Water Corporation A.B.N. 46 228 513 446

Standard Technical Specification for:

STS 600
GENERAL MECHANICAL REQUIREMENTS

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Standard – General Mechanical Requirements – STS 600

1 Purpose

This document describes the requirements of Hunter Water for mechanical equipment and associated works.

1.1 Scope

The documents scope for mechanical equipment and associated works includes:

- *Equipment design considerations* addresses items that must be considered at the design and fabrication stage for equipment.
- *Plant design considerations* (installed design) addresses items that the plant designer must consider when designing the equipment into the plant.
- *Equipment installation considerations* addresses considerations when installing equipment.

This document is written for the following Hunter Water audiences:

- planners, project managers and contract managers managing delivery of Hunter Water assets
- Designers of assets for Hunter Water
- Constructors and installers of equipment for Hunter Water
- Internal and external service providers undertaking works for mechanical equipment and associated works
- Hunter Water engineers and tradespeople.

Any electrical work carried out in conjunction with mechanical work is to be done in accordance with the requirements of *STS500 General Requirements for Electrical Installations*.

2 Interpretation

For the purposes of interpretation of this Standard Technical Specification (STS), except where the context requires otherwise:

- 'Drawings' means the drawings detailing the work involved in a particular project in hand
- ‘Include’ means including but not limited to, and is used to provide clarification or examples of the type and nature of items intended
- 'Specification' means a specification detailing the work involved in a particular project
- ‘Standards’ means applicable industry standards include the Australian Standards (AS), Australian / New Zealand Standards (AS/NZS), American National Standards Institute (ANSI) and ISO Standards (ISO) referenced in Appendix A
- 'Standard Drawings' means Hunter Water Corporation Limited drawings
- 'Standard Technical Specification' (STS) references any of Hunter Water’s Standard Technical Specifications, as implied by the text.
- ‘Mechanical’ work includes work carried out by the core trades: Fitting, Machining, Fabricating, Welding (Fabrication Engineering), Plumbing and the Engineering (Mechanical) Trade

Headings are for the convenience of the reader and must not be used in the interpretation of this Standard Technical Specification.

Unless stated otherwise any expression such as "give notice", "submit", "approval", or "directed" means give notice to, submit to, approval by, or directed by the person nominated by Hunter Water.

Approval does not imply acceptance of responsibility by Hunter Water for compliance with this technical specification. Unless approval has been issued in writing, approval has not been granted.

Failure to comply with the requirements of this Standard Technical Specification or any referred documentation may result in rejection. Where equipment and / or manufacture is rejected, notice will be given by Hunter Water in writing. All associated rectification work must be completed by the contractor at their cost.

2.1 Order of Precedence

Specific requirements, including those in project specifications or standard Drawings take precedence over general mechanical requirements in this Standard Technical Specification.

The order of precedence for this STS are, from highest to lowest are:

- Legislative requirements
- Content in this STS
- Australian Standards
- WSAA standards

2.2 Exception to this document

Any concession to any requirement in this Standard Technical Specification is valid only when authorised in writing by the Document Owner.

Project specific requirements, including those in project specifications or Drawings, take precedence over requirements in this document and do not need exception approval.

2.3 Referenced documents

In addition to STS 600, all work must comply with relevant current Australian Standard (AS), Australian/New Zealand Standard (AS/NZS) and Hunter Water reference documents, including:

- Workplace Health and Safety Regulations
- National Codes of Practice (For example, Safe Work Australia Codes of Practice)
- WorkCover NSW Codes of Practice
- Hunter Water's Standard Technical Specifications
- Hunter Waters NPV template
- ISO 9001 Quality Management Systems

A list of relevant Australian and International Standards is contained in Appendix A.

3 Roles and Responsibilities

3.1 Document Owner

The Document Owner of this Hunter Water Standard Technical Specification of General Mechanical Requirements is Hunter Water's Group Manager Planning and Engineering.

3.2 Document Owner Responsibilities

The Document Owner must:

- approve in writing the issue of any updated version of this Standard Technical Specification
- approve concessions to any requirement in this STS 600.

4 Definitions

Where the following term, abbreviation or expression occurs in this Standard Technical Specification, it is defined as follows, unless the context implies otherwise:-

Term / Abbreviation / Expression	Definition
ABS	Acrylonitrile Butadiene Styrene
AGMA	American Gear Manufacturers Association
Angularity	Angularity in the context of shaft alignment is the gap difference at the coupling edge for a 100mm diameter coupling
AS	Australian Standard, also includes AS/NZ (Australian and New Zealand Standards)
Biogas	Gas containing methane or other combustible constituents
Coastal environments	Sites up to 5km from the coast
Consumable Equipment	Equipment that is not designed for overhaul or renewal. Non-repairable equipment
De-energise	Remove stored energy
Designer	Person or organisation creating design and drawings for construction
Equipment mount	The part of the equipment that is secured to an equipment bed or to a structural element
Equipment bed	Frame that equipment is mounted to, element between equipment and plinth. Also known as baseplates.
Equipment Design Life	The required life, in years, from commissioning to disposal, including overhaul as required
FAT	Factory Acceptance Testing. FAT may be performed at the OEM factory or local to HUNTER WATER.
GRP	Glass Re-enforced Plastic
Hunter Water	Hunter Water Corporation
Industrial water	Potable water that is passed through a break tank to isolate it from the supply. Industrial water must be used for applications such as dilution of chemicals, clean water flushing and other uses that come in direct contact with the treatment process
Isolation	The activity of blocking or removing all energy sources
IP Rating	Ingress protection as described in AS 1939
IR	Infra-red Technology, Thermography
ITP	Inspection Test Plan
LCC	Lifecycle costs
LCP	Local Control Panel, see HUNTER WATER STS500.
OEM	Original Equipment Manufacturer

Term / Abbreviation / Expression	Definition
Offset	Offset in the context of shaft alignment is the maximum misalignment of shafts centre lines. Offset is measured in the X & Y axis
Operational life	Expected life of equipment in the operational environment before overhaul required. The operational life is a subset of Design Life
Overhaul	Correction of inadequacies to return equipment to original function and capacity
MS	Mild Steel
MTBF	Mean Time Between Failure, where a failure is defined as a condition which will prevent the equipment performing its intended primary functions.
PE	Polyethylene
Potable water	Water from the town drinking water supply
Proprietary	A commercial supplier's standard design of equipment or process
PTFE	Polytetraflouroethylene
PVC	Polyvinyl chloride
PVC-U	Polyvinyl Chloride Unplasticised, also known as UPVC
Qualified Tradesperson	A person with a relevant trade certificate recognised by the Department of Education and Training NSW
NDT	Non-destructive testing
NPV	Net present value
Renewal	Renewal of equipment is replacement of all wearing and/or consumable parts.
Return to service	Time from notification of equipment failure to rectification of service
RPM	Revolution Per Minute
SAT	Site Acceptance Testing
SCADA	Supervisory Control And Data Acquisition software
SI	Systeme Internationale, International System of Units
SOA	Spectrographic oil analysis
Soft foot	The condition in which one of the feet of a machine does not sit flat on the machine base. This includes parallel and angular soft foot
Special tools	Tools that are uniquely applicable to the make of equipment. Tools made to suit a particular piece of equipment and are not generally available from a retail tool outlet (catering for tradespersons) within the state of NSW, Australia.
SS	Stainless Steel, e.g. SS316 where "316" indicates the grade of stainless steel
Stainless Steel	Stainless steel means, a minimum stainless steel grade of 316, otherwise stated. The material best suited to each application must be selected.

Term / Abbreviation / Expression	Definition
STS	Standard Technical Specifications, the Hunter Water technical specifications
Submit	Submit to HUNTER WATER
SWL	Safe Working Load
Thermal growth	Thermal growth in the context of machine alignment is the change in length from the machine base to its output shaft axis.
Turndown	The minimum rotational speed the machine can be operated at, measured as a percentage of maximum operating speed
UPS	Uninterruptible power supply
UV	Ultraviolet light
VA	Vibration Analysis
VSD	Variable Speed Drive, motor starter
Wet environment	Any of the following: • outdoor area • room containing pipework which contains liquid under pressure • area where equipment is located that requires wash down • area below natural ground level • any area which could reasonably be expected to become wet through operation of the asset
WSAA	Water Services Association Australia

5 Lifecycle requirements

This section sets out the lifecycle principles for mechanical equipment for Hunter Water installations.

5.1 Design

Design of all equipment must be in accordance with relevant Australian Standards and Australian/New Zealand Standard (AS/NZS).

Equipment must be designed to meet the functional requirement, including;

- process outcomes as defined in the project scope
- design life
- material selections that are fit for service in the intended environment
- operational reliability and redundancy.

Equipment installations must be designed with:

- a means of isolation from all energy sources for maintenance and removal, compliant with Hunter Water's Isolation, Lockout and Tagging Manual. Isolation arrangement must enable stored energy to be de-energised before the equipment is maintained or removed
- clear and safe access for:
    - commissioning, operating and maintenance purposes
    - removal of equipment, with clearance from surrounding equipment and structures
    - dismantling (including pipe work)
- integration of instruments and sensors for the site PLC to control the equipment
- provision for clean air to equipment with air intakes
- a designated interface with surrounding equipment and systems, including:
    - isolation of vibration generated from normal operating
    - allowance for thermal expansion and contraction
- drainage to avoid liquids pooling on or around equipment
- vermin proofing, where vermin can impact the performance of the equipment
- the avoidance of:
    - the creation of confined spaces
    - installation of equipment in confined space
    - placement of equipment and services over water bodies
    - contact with chemicals (E.g. radar at top of tank avoids contact with chemical, compared to pressure sensor at bottom of tank)
    - work at height and the use of anchor points, for both operation and maintenance.

Note: where avoidance of all of these conditions cannot be achieved, risk assessment of the hazards must be used to determine the lowest risk solution.

5.1.1 Equipment and system sizing

Equipment must be sized for stable operation for all operating conditions.

System sizing must include multiple units to achieve stable operation across the entire operating range. Avoid equipment and system sizing that requires individual equipment to operate near the minimums of its capacity.

5.1.2 Site Environmental Conditions

Equipment installations must be designed with consideration of the following site environmental conditions:

- operate in temperatures from -5°C to 50°C
- relative Humidity of 100%
- 1 in 100-year return event for storm, rainfall, flood and wind
- bushfire risk: locate equipment outside Bushfire Asset Protection Zones
- wind conditions
- saltwater spray/mist.

5.1.3 Redundancy

Equipment redundancy must be matched to operational requirements. Factors to take into account when allowing for equipment configuration & redundancy include:

- process criticality
- operational consequence of loss of capacity
- existing redundancy, including non-equipment redundancy (E.g. overflow pond)
- potential impact on the environment
- potential impact on safety
- consequential cost of machine failure
- maintenance requirements, eg machine removal for overhaul
- response time to repair
- availability (lead time) of spares
- complexity to repair
- number of failure modes
- redundancy as a portion of total capacity (Duty/Standby, Duty/Duty/Standby, etc)
- ability to isolate for repair
- integration with existing control systems, this applies to existing installations.

5.1.4 Allowance for future expansion

Future expansion may be specified for a project. Future expansion must include the design and installation of:

- space for additional equipment
- plinths consistent with the installed equipment
- buried and concrete encased electrical cable conduit consistent with the installed equipment, unused cable conduit must have draw wire installed
- pipes installed to allow extension to the future machines, minimising interruption to processes. This may require allowance for a stop valve and blanking flange
- lifting coverage, consistent with the installed equipment, when overhead lifting is provided. Lifting hoists specifically for the future equipment does not need to be supplied.

5.2 Equipment Manufacture

Equipment must be manufactured to a quality management system, as defined in ISO9001.

5.3 Equipment and Materials Supply

Use equipment and materials listed on the Hunter Water **Approved Products and Manufacturers List** available on the Hunter Water website.

Select equipment from Hunter Water's Approved Products List to minimise lifecycle cost (LCC) for the intended application. Where the equipment type is not covered by Hunter Water's Approved Products List, the equipment must have 3 years operation in Australia or 5 years operation overseas, with references and performance history in a similar application that can be assessed by Hunter Water.

Equipment selection must take into account the availability of parts and/or replacement equipment. The availability of equipment and/or parts must be matched to the operational requirements, so that replacement parts can be sourced within the return to service timeframes.

Preference must be given to equipment that:

- has spare parts stocked in Australia, and
- is supported by maintenance technicians in the Newcastle Region or able to be onsite within 4 hours.

During procurement of equipment the following information must be provided:

- equipment servicing requirements. Including condition monitoring requirements, including operator observation, VA, IR, SOA
- detail equipment drawings. The detail drawings of the equipment must include a dimensioned general arrangement, indicating the minimum clearance distance required for removal of components when the equipment is installed
- static loads (weights)
- dynamic loads.

Where the project specific specification calls for equipment servicing for the duration of any OEM warranty, the equipment must be principal supplied, in order for continuity of contract relationship.

5.3.1 Equipment compatibility

Equipment must be identical and interchangeable without the need for modification, where multiple items of equipment are supplied and installed to perform a particular function (duty/standby arrangements).

5.3.2 Reliability

The reliability information must be provided for each item of equipment in the specified operating environment including the source of reliability data. If the reliability performance is based on:

- calculation, the basis and methodology for the calculation must be provided
- actual installed performance, the source of the data, including details of the installation and methods of verification must be provided.

Determination of the reliability data should take into account:

- Hunter Water service level obligations
- equipment duty cycle
- operating environment, and
- single points of failure and method(s) to avoid them.

Reliability data must include the MTBF, where a failure is defined as a condition which will prevent the equipment performing its intended primary functions.

Failure modes and effects criticality analysis must be undertaken during the detail concept design phase of projects for new equipment.

5.3.3 Factory Acceptance Testing (FAT)

Where the project Technical Specification calls for FAT of mechanical equipment, suppliers must provide 21 days notification prior to despatch of equipment to site.

Hunter Water may perform FAT inspection on equipment that:

- is process critical
- can be performance tested
- has a high level of complexity
- is new to Hunter Water's fleet of equipment, or
- as required by Hunter Water.

5.4 Installation

Equipment installation at Hunter Water must:

- comply with relevant Australian Standards, legislation and codes of practice
- be on engineered structures that meet the design life of the equipment and allow for alignment and adjustment of machines. Engineered structures include motor beds, plinths and structural steel.

All installation work must be carried out:

- by individuals who are suitably competent, qualified, experienced and authorised by licencing where required
- in a professional manner to current industry standards
- under the supervision of individuals meeting the requirements of the preceding statements where tasks are carried out by apprentices / trainees / trades assistants.

5.5 Commissioning

Commissioning of equipment must comply with the Hunter Water Technical Specification Testing, Commissioning and Process Proving. Commissioning of mechanical equipment must:

- demonstrate all the functions of the equipment
- confirm the equipment is fit for purpose and meets its specifications
- confirm the operation of all safety features
- demonstrate safe access for operation, maintenance and removal
- include an audit of the equipment installation for compliance with HWC mechanical Standard Technical Specifications.

Note: this clause applies to all stages of commissioning, and may be applicable to FAT, pre-commissioning or commissioning.

5.6 Drawings and documentation

5.6.1 Drawings

Equipment and system drawings must be supplied for all equipment to be installed after completion of detailed design and prior to installation, for acceptance.

Equipment drawings are acceptable in the OEM format, in English language.

5.6.2 Maintenance manuals

All equipment must comply with the requirements of Hunter Water STS906. Mechanical equipment maintenance manuals must contain:

- detail drawings of fabricated components
- contact details of OEM
- contact details of supplier agents and/or parts suppliers
- list of warranty details
- commissioning and re-commissioning procedure
- contain detailed parts lists and associated drawings for all equipment
- OEM maintenance manuals. Material in the OEM manual that does not directly relate to the installed equipment is to be removed or shown in strikethrough (~~strikethrough~~)
- maintenance schedules as recommended by the OEM. This information may be requested during design stages to assist in lifecycle analysis
- additional maintenance requirements as determined by the designer.

5.7 Condition monitoring

Equipment failure must be detectable, monitored failure modes of equipment must generate a SCADA alarm or similar prior to the machine damaging itself. Protection must be installed to prevent equipment from damage in the event of a component failure or an unsafe condition.

Condition monitoring program must be recommended for equipment by the designer or OEM for acceptance by Hunter Water. Condition monitoring includes sensory observation and measurement to VA/IR/SOA.

5.8 Overhaul and Consumable Equipment

Routine overhauls required to achieve operational design life must be recommended by the designer and documented in the design report.

Equipment that is not designed to be repaired or considered consumable must be identified during design and documented in the design report or equivalent project documentation.

5.9 Condition Assessment

Condition assessment of equipment and its system must be performed in conjunction with:

- replacement of equipment
- upgrade of equipment
- enhancement of equipment

- failure of equipment
- investigation of equipment performance, and
- equipment overhaul.

A condition assessment must identify:

- degradation of associated system elements
- fitness for service of associated system elements
- that operational requirements must continue to be met after any change
- estimated remaining operation life where degradation has occurred
- compliance with Hunter Water standards, and
- compliance with current Australian Standards and regulatory requirements.

5.10 Modification of equipment

Equipment that is modified must have all elements of the machine (or system) condition assessed or reviewed to ensure they operate within its design capabilities when it is modified. Machine/system modification must take into account:

- current Hunter Water operational strategies
- current Hunter Water maintenance strategies
- hunter Water standard technical specifications, and
- Australian Standards.

Modification of equipment must apply Hunter Waters change process Standard - Management of Technical Change. All relevant/affected drawings and documentation to be reviewed and revised for reissue when equipment is modified.

5.11 Decommission/disposal

Equipment design and installation must take into account:

- removal and decommissioning requirements
- disposal of unsafe or environmentally hazardous materials, and
- potential replacement with alternate equipment or re-use of that position.

6 General Mechanical Requirements

This section sets out:

- general requirements for mechanical equipment
- specific design requirements for specific design elements of mechanical equipment
- mechanical requirements for the:
    - design of equipment
    - design of the equipment installation
    - installation of equipment.

6.1 Access arrangements, stairways, landings, walkways and ladders

Design and install stairways, ladders, walkways and landings in accordance with AS1657.

In addition to AS1657:

- stair tread must have serrated load bars and an abrasive nosing that is yellow in colour
- kick boards must be provided around product streams to stop foreign materials entering the treatment process
- kick boards must be connected by threaded fasteners (not welded in position) and be removable
- handrails and stanchions must be metallic
- handrails must be welded to stanchions
- stanchions must be bolted to walkways
- joints in handrail/guardrail must be inside stanchions
- stairways and walkways must be a minimum of 0.9m wide, the 0.9m is measured as clear width on the inside of the handrail system
- handrail/guardrail stanchions must be at a maximum spacing of 1.8m
- handrailing and guardrailing (definitions per AS1657) must not be used for mounting equipment or as a support system for plant services. Provide separate support systems for services and equipment – see section 6.22 Services Routing
- vertical overhead clearance on walkways must be a minimum of 2.4m
- floor grating clips must be removable by tool
- permanent ladders must not be used
- stainless steel ladder tie off points must be provided, where access by portable ladder is approved by Hunter Water.

6.2 Anchor bolts (non-equipment)

This clause applies to static items, non-rotating equipment, including,

- pipe supports
- structural members
- bracket mounts in chemical bunds

Anchor bolts between static items and concrete must be:

- stainless steel
- 100mm or a minimum of 6 times the nominal bolt diameter (whichever is greater) from the edge of the concrete plinth
- perpendicular to the concrete face
- be positioned inside steel reinforcing, and they must not be installed with only concrete between the hole and the edge of the concrete
- be inspected by Hunter Water, after the drilling of the hole and prior to the insertion of the anchor, for installations where the anchor is over 16mm diameter and/or hole depth requirement is greater than 150mm
- be installed prior to static item placement/installation. Holes for chemical anchors must not be drilled through static item feet
- not be drilled through re-enforcement within the concrete
- avoided inside chemical bunds and other liquid retaining structures
- refer to section 6.7 Fasteners for additional requirements.

6.3 Anchor points (Working at heights)

6.3.1 Anchor point design

The design of anchor point installation must:

- allow safe access and connection without exposure to heights risk, in accordance with AS1657
- be located more than 1500mm from the opening it will be used for, and any other adjacent fall risks
- be located so they do not get covered by hole covers and can be used when removing covers from holes
- allow un-obstructed movement of the anchor users when attached to the anchor point
- be installed a minimum of 100mm from the nearest edge or construction joint, where installed in concrete
- be shown on a site plan, identifying anchor points for the whole site.

6.3.2 Anchor point testing and maintenance

Fall restraint anchor points must be:

- fasted to structural components, not friction or glued anchors
- tested after installation and annually in accordance with AS1891.4 by a NATA accredited agency
- test tagged must be fitted after each test.

6.4 Bearings

6.4.1 General

Bearings must be rated in accordance with AS2729.

Bearings, bearing seals and bearing housings must be commercial off the shelf items, stocked in Australia.

Bearing seals must protect the bearing from ingress of foreign material and egress of grease, for the life of the bearing.

Bearing lubrication points must be accessible from ground or platforms. Access must not involve exposure to heights, confined spaces or machine elements that require guarding. Wasted grease from bearings must be captured for disposal; bearing housings must not waste lubricant into the associated process material.

Suppliers of equipment must provide bearing lubrication requirements and record these in a table on design drawings or in the machine maintenance manual. Bearing lubrication requirements include:

- lubricant specification
- capacity
- feed rate.

6.4.2 Rolling element bearings

Rolling element bearings must:

- be rated in accordance with AS 2729, for a minimum design life of 10 years of continuous operation
- be grease lubricated
- have grease pressure relief devices fitted to bearing housings on dry-mounted equipment with shaft diameter 40mm or greater (excludes submersible machines).

Rolling element bearing housings must be fitted with seals. Bearing housing seals must be adequate to stop ingress of foreign material, including water, grit, and process materials.

Bearing isolators, labyrinth and lip seals should be used along with improved sealing and lubrication arrangements to achieve the design life of equipment in any of following environments:

- wet environments, including subject to washdown
- submerged or partially submerged
- in contact with sewage or other wastes
- exposed to corrosive gases
- exposed to corrosive liquids
- located in a coastal environments
- subject to an abrasive environment.

6.4.3 Plain (journal) bearings

Plain bearings may be considered for:

- submerged environments
- abrasive environments

- slow rotating applications
- heavy load applications.

Submit plain bearing design and application to Hunter Water for approval. This must include drawings, materials, tolerances, lubrication requirements, expected life, maintenance/procedures and sealing arrangement.

6.5 Condition monitoring

Equipment that has integrated condition monitoring sensors must be design and installed for the sensor signals to be returned to the site PLC. Examples of integrated condition monitoring sensors include sensors for vibration, temperature and pressure.

6.5.1 Vibration of machines

Rotating equipment must be mounted:

- to meet the vibration limitation requirements of ISO 20816-1
- to operate with minimal self-induced torsional and translational vibration
- to isolate any vibration from or to surrounding equipment and structure
- with balanced couplings between machine and driver.

VA studs for use with portable hand held instrument must be installed for:

- machines with motors 30 to 75KW (excludes submersible equipment).

VA studs must be:

- made from stainless steel
- have a flat machined surface of minimum diameter 16mm of flat surface contact area

New installations must have permanent vibration and temperature monitoring when:

- machines have motors greater than 75KW.

Permanent VA installations must include:

- a minimum of 2 sensing points for each bearing.

Where temporary vibration monitoring is required for existing installations, mobile vibration and temperature monitoring must include wireless sensors that meet the following requirements:

- are internet enabled
- continually collect orbital vibration and contact surface temperature;
- data is extractable in a Microsoft Excel format
- data produced remains the property of Hunter Water
- data is accessible after the monitoring period ends.

6.5.1.1 Mounting of VA studs and sensors

Vibration measurement locations must be documented on the machine layout drawing. The proposed locations must be approved by Hunter Water prior to fitting. Vibration measurement studs and sensors must be:

- mounted on a rigid member of the machine, as close to each bearing as possible ie bearing housings, machine casings or mounting blocks
- perpendicular to the centre line of rotation

- minimum 10mm thread
- fitted by threading and tapping into the machine, with a thread adhesive
- outside of guarding
- not on flexible covers or shields such as motor fan covering or a sheet-metal guarding
- following manufacturer's guidelines.

Required measurement positions and orientations on a machine's surface must be identified using the following designation:

- measurement locations must be named consecutively in the direction of power flow:
    - non-drive end
    - drive end
    - horizontal, and
    - vertical
- measurement locations must be numbered consecutively in the direction of power flow:
    - position 1 designates non-drive end bearing of the driver unit of the machine. The highest position number designates the bearing location at the terminating bearing location of the driven machine, furthest from the drive.
- when a machine station consists of multiple components, such as two or more spindles, consecutive numbering of components must be in the direction of process flow.

Vibration measurement must be mounted in order to meet the vibration limitation requirements of;

- ISO 20816-1 Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts General guidelines
- AS 2679 Vibration and Shock - Mechanical vibration of rotating and reciprocating machinery - Requirements for instruments for measuring vibration severity
- ISO 2954 Mechanical vibration of rotating and reciprocating machinery - Requirements for instruments for measuring vibration severity.

Vibration measurement must be performed for new and rebuilt rotating equipment, greater than 30kW, during commissioning.

6.6 Equipment mounting arrangements

Install and align equipment in accordance with the manufacturer's written instructions. Installation instructions must include:

- a procedure for installing each component of equipment supplied
- drawings showing in detail all the main components to be installed along with their overall dimensions and weights
- a method for safely lifting and handling equipment and equipment components
- details of methods, settings, tolerances and adjustments required to correctly install the equipment and make it ready for operation
- a list of equipment and instruments required for adjusting and checking the accuracy of settings and adjustments that are specified by the manufacturer.

Equipment must be mounted:

- with positive support between equipment bed and plinth, by jacking nuts (preferred) or shims, these must be sacrificial for grouting
- to avoid induced mounting stresses (such as pulling motor/machine to machine bed)

- with clear access to fasteners.

6.6.1 Equipment plinth

Equipment plinths must:

- be designed for equipment specific start up torques and operational loads
- be:
    - raised above the surrounding concrete slab, or
    - at the same relative height as the surrounding concrete slab, with the plinth mass below the surrounding concrete slab
- extend a minimum of 100mm beyond the mounted item on all sides (see Anchor Bolts)
- be self-draining, with drainage holes/channels sized and located to prevent blockage
- be integrated into surrounding concrete and reinforcing (keyed in).

6.6.2 Equipment bed

Equipment beds must be designed and install to provide a stable, flat platform for equipment, facilitating accurate alignment, and without inducing stresses to the equipment or equipment bed. Equipment beds must be designed, manufactured and installed:

- to achieve a maximum overall vibration level of 1.5 mm/sec at any point in any direction when operating at rated capacity and temperature
- with stiffness confirmed during acceptance testing/commissioning by a vibration survey at each bearing, measuring:
    - 2 radial directions at 90 degrees to each other, and
    - one reading in the axial direction
    - if any of the vibration readings are above 1.5 mm/sec the supplier must make necessary modifications and adjustments to reduce the vibration reading to below the acceptable level. Equipment will not be accepted until testing is passed to these criteria.

Equipment beds and baseplates design must:

- be designed to be grouted in place, with grout injection ports of minimum 60mm diameter
- have the driven machine and mounting surfaces coplanar and parallel within the pump and motor manufacturers tolerances
- be designed to have the centreline of the motor at least 3mm lower than the equipment centreline
- have tapped holes at least 1.25 bolt diameters deep for use with machined screws for holding down bolts
- provide for collection and controlled drainage of process product, lubricant or coolant
- have permanent drain lines for collection and disposal of fluid, where the capacity exceeds 5 litres (eg gearbox oil)
- have mating faces with equipment milled flat after the final production stage (fabrication, galvanising or casting) at the contact area for the mounting of motors/engines and equipment
- have permanent jacking bolts to assist in alignment, jacking bolt to be aligned with motor hold down bolts, 4 jacking bolt per motor, 2 bolts located at each side of the motor
- have clear access for anchor bolt holes and equipment hold down bolts
- have AS2317 compliant eye bolts for lifting
- not be fabricated from folded metal
- not be subject to deflection under operating loads

- not be subject to deflection induced by adjoining equipment or pipework, and
- not be encased or embedded in concrete.

6.6.3 Anchor bolts

Anchor bolts are the interface between equipment or equipment bed and the concrete plinth or structural element it is mounted on. Equipment anchor bolts must be:

- designed for start up torques and operational loads for rotating equipment or in accordance with manufacturers recommendations
- stainless steel
- 100mm or a minimum of 6 times the nominal bolt diameter (whichever is greater) from the edge of the concrete plinth
- perpendicular to the concrete face
- refer to section 6.77 Fasteners for additional requirements.

6.6.3.1 Integrated anchor bolts

Anchor bolts must be integrated with reinforcing if:

- the equipment has drive power greater than 50kw (nominal) or weighs more than 250kg (nominal), or
- nominated by the equipment manufacturer, or
- nominated by the designer.

Integrated anchor bolts must be:

- detailed on design drawings, showing details of anchor integration
- an ‘L’ or ‘J’ shaped, or hook bolts, and secured to the reinforcing in the concrete,
- cast into the plinth or concrete slab in a manner (such as removal foam) that allows minor re-alignment of the anchor and then grouting during installation.

6.6.3.2 Chemical anchors

Chemical anchors may be used for static/stationary equipment, provided the equipment has drive power less than 50kw (nominal) or weighs less than 250kg (nominal). The chemical anchors must:

- comply with manufacturers installation guidelines for embedment (hole depth), hole diameter and edge distances
- be perpendicular to the concrete surface
- be positioned inside steel reinforcing, and they must not be installed with only concrete between the hole and the edge of the concrete
- be inspected by Hunter Water, after the drilling of the hole and prior to the insertion of the anchor, for installations where the anchor is over 16mm diameter and/or hole depth requirement is greater than 150mm
- be installed prior to machine placement/installation. Holes for chemical anchors must not be drilled through machine feet
- not be drilled through re-enforcement within the concrete.

6.6.4 Grouting

The void between equipment/equipment beds and plinths must be grouted to minimise the potential for corrosion or other degradation of the equipment/equipment bed through accumulated or incidental contact with moisture.

Grouting must:

- be performed after the machine has been aligned
- be performed according to the grout manufacturers' instructions
- be a minimum of 25mm thick to allow flow of the grout into position and a maximum of 50mm thick, from the plinth to the equipment/equipment bed
- fully encase jacking/lock nuts and/or shims supporting equipment/equipment bed
- allow fluid/debris to drain away from the equipment or equipment bed, and
- be non-shrink, flowable, cementitious grout with a minimum compressive strength of 50Mpa at 28 days.

6.6.5 Alignment – flexible couplings

Motor and machine assemblies with flexible couplings must be aligned to meet:

- the manufacturer's recommendations for the motor and machine, or
- the requirements in the Alignment Tolerance table below if this is a higher order (based on maximum machine speed)

Equipment/equipment beds must be fully secured and grout cured prior to alignment.

6.6.6 Prime Mover (motor) to machine alignment

This clause applies to machines with concentric flexible couplings.

Motor alignment process must include:

- measure and record soft foot condition
- correct any soft foot condition
- measure and record angular and offset misalignment before alignment
- measure and record angular and offset misalignment after alignment
- calculate theoretical thermal growth
- realign to account for actual thermal growth, when the calculated thermal growth is greater than 50% of the target misalignment (see table)

Allowable misalignment for machine couplings, after taking into account thermal growth, is included Table 6.1.

Table 6.1 - Alignment Tolerances

RPM		Acceptable (mm)	Target (mm)		Acceptable (mm)	Target (mm)
750	Offset	0.12	0.09	Angularity Per 100/100mm	0.12	0.09
1000		0.09	0.07		0.08	0.06
1500		0.09	0.06		0.07	0.05
3000		0.06	0.03		0.04	0.03

Motor and machine alignment must be achieved:

- with proprietary toleranced stainless steel shims
- with 4 or less shims per foot
- without modifying hold down bolts, i.e. turned down bolt shanks
- without modification of holes in the feet of motor or bed, i.e.do not slot holes.

6.6.7 Mounting on Walls (Sole Plates)

Sole plates must be used when mounted/fastening equipment to the top of walls. Sole plates must be used for machines (e.g. step screens, penstocks) and structures (e.g. walkways). Sole plates must:

- be minimum 16mm thick stainless steel
- have stainless steel legs:
    - welded to the underside of the plate by continuous fillet weld
    - of minimum length 250mm
    - with a “fishtail” end or an “L” shape to engage with the concrete
    - positioned to avoid interference with re-enforcing
- be installed:
    - with the top surface flush with top level of surrounding concrete wall
    - tie wired to the steel reinforcing or positioned into the wet concrete during the concrete pour, then have vibration applied to the wet concrete to ensure the concrete surrounds the legs
- have SS thread welded by continuous fillet weld to the top of the sole plate for fastening the equipment. The threads must be welded after sole plate is inserted in concrete and concrete cured
- have grout between the sole plate and the machine foot, consistent with section 6.6.4 Grouting. An adhesive may need to be applied to the top of the sole plate.

6.7 Fasteners

Threaded fasteners must be metric and comply with AS1110, AS1111, AS1112 and AS1275. In addition to these Australian Standards:

- fasteners (including washers and nuts) must be of the same material as the equipment being fastened, otherwise:
    - where dissimilar metals are used in the fastening of equipment, insulating washers and sleeves must be used
- threaded fasteners, nuts and washers must be of the same material and grade
- washers must be fitted under all nuts
- washers must be fitted under bolt heads for connections to equipment with protective coatings and where the bolt head will be rotated
- tapered washers must be used where the part under the bolt head or washer is not perpendicular to the centreline of the bolt
- use self-locking nuts where the connection is subject to vibration and for vertical bolts in tension
- threads must have application specific lubricant applied, except situations where a thread locking compound is required
- stainless steel fasteners must have stainless steel compatible thread lubricant applied, except situations where a thread locking compound is required
- the length of bolts must be sized to have a minimum of 3 threads (nominal), and a maximum of 1.5 times the bolt diameter thread protruding from the nut. Multiple washers, nuts or packers must not be used to meet this requirement
- thread ends must be cut square, chamfered and deburred to make safe, and ensure positive nut engagement
- where a fastener is cut to length the cut surface must be coated according the Hunter Water coatings specification
- anchors, bolts, nuts and washers embedded in concrete or encapsulated in concrete or grout must be stainless steel
- stainless steel fasteners must have a rolled thread, cut threads will not be accepted
- do not use wingnuts, butterfly nuts or other fasteners intended to be adjusted by hand
- do not use threaded bar in place of bolts.

Threaded bar must:

- only be used where access prohibits use of a bolt
- have a hex head end, an Allen key socket end or 2 machined flat faces (to a metric dimension) at the end so the threaded bar can be gripped for disassembly
- meet the requirement of full threads past the nut, as above.

Fasteners must be tightened to the recommended torque using a torque wrench and recorded on Inspection Test Plans. This clause applies to bolts which are:

- on structures
- stainless steel
- inaccessible after construction/assembly is complete
- encapsulated, such as by grout
- not accessible from ground or platform
- on or associated with machines.

6.8 Fail safe systems (back-up systems), E stops

6.8.1 Fail safe systems (back-up systems)

Machinery must be designed to leave the plant, process or equipment in a safe condition in the event of failure of part of the equipment or its associated safeguards, control or power supply.

Fail safe systems must be designed to allow maintenance and regular testing of the functionality of the fail-safe system. Fail safe systems or back-up systems include (but not limited to):

- valve fail safe systems
- generators
- batteries, and
- UPS's.

Fail safe mechanisms for valves must be a spring.

6.8.2 Emergency Stops

Emergency stops must comply with STS500.

6.9 Gaskets

Flange gaskets must comply with WSAA109 industry standard, AS4087 and AS1646. In addition:

- the gasket material must be suitable for contact with the flange material, product, operating conditions and environment
- full face gaskets to be used for pipe flanges
- gaskets must be able to be workshop fabricated from flat gasket stock
- pipes and fittings must be in their correct position, alignment and grade before the joints are made, and no springing of joints is permitted
- avoid proprietary gasket systems, such as o-rings or spiral wound gaskets
- do not specify or use liquid sealants in place of gaskets.

6.10 Guarding of equipment

Equipment must be guarded in accordance with AS 4024. Guards must be provided for protecting personnel against hazards including:

- contact with moving parts
- hot (above 50ºC) or cold (below -5ºC) surfaces
- radiation (UV, light, laser)
- hazardous process products (biological)
- chemicals.

Equipment guards must:

- be removable without the need to dismantle the equipment or surrounding equipment
- be removable without disturbing sensing devices, chain or belt tensioners, instrumentation or lubrication systems
- be yellow, AS2700 colour code Y14, and comply with WSA201
- be matt black for mesh witness panels in guards
- not have ancillary equipment mounted on them (such as sensors or lubrication systems)
- not impede the reading of equipment nameplates. Nameplates can be repositioned to ensure they are readable.

Where there is an operational/maintenance requirement for visual inspection, a means of inspection must be provided, eliminating the need to remove the guard. Examples include clear windows, mesh or inspection covers. Inspection covers must have an additional internal mesh guard or an interlock that prevents exposure to hazards when the inspection cover is open.

Fences as guards must:

- not be used on new installations
- only guard the equipment that requires guarding
- not inhibit access to equipment that does not require guarding
- have gates interlocked with machines inside the fence
- only be considered on existing installations.

6.10.1 Physical Protection of Equipment

Machines and associated components (including pipes and services) must have physical protection where they can be impacted by vehicles, mobile plant, and lawn maintenance equipment. Physical protection can take the form of:

- bollards
- kerbs
- fencing
- physical guarding.

6.10.2 Hazardous Area Zone

Hazardous areas must be fenced and sign posted. The fence must exclude human access, and must be provided with a minimum of 2 lockable gates that enable emergency egress in different directions. E.g. explosive atmosphere area.

6.11 Instruments

Instruments fitted to machines must:

- indicate on the applicable SI scale
- be guarded where their positioning may lead to damage during operation, maintenance and inspection activities in the vicinity of the instrument
- be guarded for water and weather impact
- be installed at a position that produces accurate results, specifically:

    - pressure transducers and pressure gauges must be installed at the height of the pipe tapping where the pressure is being sampled
- pressure transducers must have an isolation valve and bleed (vent) valve to allow depressurisation of the valve and bleeding of the supply line.

6.12 Insulation

The requirement for pipe and equipment to be insulated must be determined during the design with reference to climatic conditions, location and solar gain. Thermal insulation of pipe and equipment is required where there is a risk of:

- freezing or crystallisation of the material due to low temperatures, or
- where high ambient temperature or solar gain may adversely affect the pipe or equipment and its pressure rating, or
- where there is a risk of dissolved gasses being released as a result of the vapour pressure being reached due to increased temperature or reduced pressure.

Where insulation is required, the minimum wall thickness must be 25mm and the minimum thermal conductivity must be 0.0346 W/m•K, yielding a minimum R-value of 1.0.

6.13 Pressure gauges

The pressure gauges must:

- have a maximum value that is no more than twice the maximum expected pressure and be calibrated in kPa
- be constructed of stainless steel
- be bottom mounted, with a 10mm (3/8 BSP) threaded fitting and 10mm full bore ball valve
- be glycerine filled
- have face of minimum diameter 63mm
- have an isolation ball valve installed prior to the pressure gauge
- have an isolation diaphragm when fitted to chemical systems
- chemical pressure gauges must have a chemical resistant diaphragm to protect the pressure gauge.

6.14 Lifting arrangements

Lifting equipment must comply with Hunter Water's Standard Technical Specification STS 640. Lifting plans must be provide for all equipment 50kg or greater.

Permanently installed lifting equipment must be provided for equipment greater than 50kg that meets one or more of the following conditions:

- installed in a covered area, housed under or within a structure (this excludes circumstances where the cover or roof is designed for removal, e.g. wet wells), or
- it is cost effective on a LCC basis to include a permanent lifting device rather than hire mobile cranes/lifting devices, or
- response time to return the equipment to service necessitates a permanently installed lifting solution (as defined during detailed design), or the processes requires the equipment to be lifted in less than 4 hours from time of failure, or

- determined through risk assessment, even when none of the above mentioned requirements are met.

(50kg is based on Hunter Water's fatal risk standards, which limits a 2 person lift to 50kg.)

Where lifting systems are installed and the equipment is greater than:

- 450kg, provide electric hoist for vertical movement
- 900kg, provide electric hoist for vertical and motorised horizontal movement (travel and traverse).

Permanently installed lifting must:

- have a lifting capacity greater than the complete weight of any machine it can lift (I.e. the crane must not be sized for partially dismantled machines)
- enable movement of the item directly from the crane onto a road transport vehicle for transportation off-site. This requirement is optional for davits.

Lifting lugs or eyebolts must be fitted to equipment or serviceable components of over 50kg.

6.14.1 Mobile Crane Lifting

Lifting arrangement for mobile cranes will be designed to:

- minimise the mobile crane size required to perform the lift
- avoid lifting over other equipment and water bodies
- show that ground conditions are suitable to support the proposed crane outrigger loads
- address crane access and show on vehicle movement plan in site drawings
- address provision of hard stand(s) for laydown of equipment. Where the equipment to be lifted contains wastewater or is submerged in wastewater, the laydown area must be used for washdown prior to transport off-site. The laydown area must drain to a sump or to a wastewater stream
- achieve overhead powerline clearance consistent with STST500.

6.14.2 Crane sizing

Crane sizes relative to the largest lift must be sized according to Table 6.2 below. The sizing must be applied to all components of the crane.

Table 6.2 - Crane Sizing

Heaviest equipment assembly	Crane size: Lift is visible and accessible	Crane size: Lift if submerged or inaccessible prior to lift
0-2 tonne	Heaviest lift	Heaviest lift + 100%
2-5 tonne	Heaviest lift	Heaviest lift + 50%
>5 tonne	Heaviest lift	Heaviest lift + 20 % or as agreed with Hunter Water crane engineer

6.14.3 Portable cranes

Portable cranes can be used for lifts up to 450kg, where lifting beam supprts are a maximum of 2.5m apart. Designers must identify the advantages of a portable crane solution over a permanent crane or use of a mobile crane (with no roof) during the design phase. Where portable cranes are proposed for lifting,

they must be represented on drawings to show how and where they are placed and how the load is transferred for movement out of the building.

Proposed portable cranes must be available from a Hunter Valley based supplier, who can deliver and erect the portable crane.

6.15 Lubrication

Provide lubrication on rotating equipment; either via a periodic or continuous system. Lubrication points must:

- be directly accessible by a manual grease gun
- be plumbed to an accessible point or bank of grease nipples (grease station), where grease points are not directly accessible. Grease lines must be:
  - plumbed along the shortest practical route
  - a minimum 8mm internal diameter
  - a maximum of 2m long
  - made of stainless steel tube or stainless steel braided PTFE hoses
  - assembled with threaded connections
  - labelled, indicating what the grease line connects to and what grease is to be used for each grease line. Labels must comply with the Hunter Water equipment labelling STS
- utilise grease stations to enable application of grease from a single location on equipment, where practicable
- have a cap, this includes grease nipples and oil fillers
- include a facility to prime each capillary line
- waste lubricate into a container for disposal. Where the waste grease escapes in multiple location, multiple waste containers are required
- lubricant released from equipment must not enter the process/product.

Bearing housings that can come into contact with potable process water must have bearing materials, lubricant and paint that comply with AS4020.

Machine installers must supply lubricants for storage, transportation and commissioning of equipment, in accordance with the manufacturers recommendations.

6.15.1 Automatic lubrication

Where a bearing requires periodic greasing, monthly or more frequently:

- automatic greasers must be fitted
- the grease feed rate must be calculated for each bearing, based on bearing model, speed and environment
- the grease feed rate must be include in the Operations & Maintenance Manual.

6.15.2 Single point lubricators

Single point lubricators must be used for equipment with up to 3 lubrication points; multipoint lubrication machine must be used for equipment with more than 3 lubrication points. Single point lubricators must have:

- a visual indicator of grease storage level.

6.15.3 Multipoint lubrication machines

Multipoint grease lubrication machines must be installed for machines with 4 or more grease application points. The machines must:

- have grease lines of maximum 4m
- a maximum of 20 grease points lubricated from one machine
- use non-proprietary cartridges
- utilise standard 20kg grease pails or 450ml grease cartridges, to achieve 3 to 5 months' supply of grease
- include blocked line alarm for individual lines; Self-monitoring on grease pressure & flow with the ability to alarm any greasing point not being greased e.g. high pressure (blocked), low pressure (broken supply line)
- include a low (20% remaining) grease alarm
- be powered by site services compressed air supply with electrical control valves. Use 240V where site services compressor not present. Do no use a dedicated compressor for the multipoint lubrication machine
- be IP65 rated (minimum)
- labelled, indicating what the grease lines connects to and what grease it to be used. Labels must comply with the Hunter Water labelling STS.

6.16 Materials

6.16.1 General

Materials must be:

- suitable for the purpose, duty and durability
- provide a service life matched to the machine/equipment life in the application and installed environment
- insulated where dissimilar metals are used
- UV stable
- handled, transported and stored in accordance with relevant legislation, Australian Standards and manufacturer's recommendations
- new and unused.

For equipment in contact with sewage or its constituents (including gases), the following materials must be used:

- stainless steel
- aluminium (corrosion resistant alloys e.g. alloy 6061-T5)
- non-metallic corrosion resistant materials such as FRP, ABS, PVC-U and polyethylene.

Material grades stated in this STS represent a minimum, and materials of a higher quality may be used, subject to Hunter Water approval.

Used or recycled material will be considered on a case by case basis, and must be approved by Hunter Water prior to inclusion in a design. A detailed description of the composition and origins of recycled and re-used materials must be provided with the application for approval.

6.16.2 Asbestos & Carcinogens

New equipment, materials and components must not contain asbestos.

Equipment, materials and components supplied to Hunter Water must not contain a prohibited carcinogen in accordance with WHS Regulation, Section 380 and Schedule 10, table 10.1.

A restricted carcinogen must only be used in accordance with WHS Regulation, Section 381 and Schedule 10, table 10.2.

6.16.3 Potable Water Contact

Any material or equipment which is in contact with potable water must comply with AS 4020 Testing of products for use in contact with drinking water.

6.17 Metalwork

Carry out metalwork in accordance with relevant Australian Standards, including but not limited to those contained in Appendix A.

6.17.1 General

All metalwork must:

- have all sharp edges and corners de-burred and rounded where appropriate; with the minimum amount of material removed to achieve a safe and functional result
- be free from twists, bends, open joints and sharp edges/corners at commissioning
- be performed with protection for surrounding site equipment when performed on site, from issues such as weld splatter, grindings and swarf.

The resultant component/assembly/system must be safe and fit for purpose, once manufactured, assembled, installed, or modified.

6.17.2 Assembly of machines and fabrications

Assembly holes must:

- be drilled as required for the mating of component parts (not flame cut)
- be spaced sufficiently distant from the nearest edge to ensure strength of joint and resistance to break through, and must be greater than 1.5 hole diameters from the nearest edge
- not be elongated or enlarged to achieve mating of misaligned components.

6.17.3 Fabrication

Fabrication must be:

- carried out by appropriately qualified tradespersons.

Frame members constructed from hollow sections must be fully closed and sealed ends to prevent the ingress of moisture.

Fabricated components must be inspected and quality assured in accordance with design drawings.

6.17.4 Fitting

Fitting must be:

- carried out by qualified tradespersons or supervised trades assistants.

6.17.5 Galvanised Steel

Steel galvanising must be in accordance with AS1214, AS 4680, and AS4792.

Galvanised materials must:

- be joined by drilled hole and bolted connection
- be drilled for connection of attachments, prior to galvanising
- not have hot work performed post galvanising.

Where galvanised materials require drilling, post galvanising, the holes must be:

- re-coated to provide a continuous coating.

Galvanised hollow frame members that can become submerged must have bleed holes that are sealed after galvanising. Sealing of bleed holes must be:

- by tapped thread prior to galvanising, and then plugged after galvanising with a threaded corrosion resistant plug
- where bleed holes cannot be plugged, they must be located at the lowest point, to allow the item to be self draining.

6.17.6 Machining

Machining must be:

- carried out by appropriately qualified tradespersons.

Machined components must be inspected and quality assured in accordance with design drawings.

6.17.7 Site Hot Work

Site hot work (including welding, heating, grinding and thermal cutting) must only be carried out:

- when necessary and unable to be carried out in a welding fabrication workshop
- within a Hot Work Permit, detailing risk mitigation measures, using the site safety plan hot work procedure; which must address ventilation and screening
- with written approval from Hunter Water

6.17.8 Tolerances

Metal fabrication tolerances must be in accordance with AS4100 (clause 14.4). Tolerances must be specified on design drawings when required for safety, functionality or durability. These tolerances include:

- size dimensions
- limits and fits of machined components
- parallelism and perpendicularity
- surface finish.

6.17.9 Welding

Welding must be:

- carried out by appropriately qualified tradespersons, in accordance with AS1796
- passivated for stainless steel welding

Welds must be inspected, tested and quality assured in accordance with:

- Australian Standards, and
- design drawings.

NDT must be performed when:

- required to comply with the relevant AS, or
- specified on design drawings.

Certified results of weld inspections and NDT must be provided with project handover documentation.

6.18 Noise assessment and acoustic enclosures

Equipment noise levels, under normal operating conditions, must:

- comply with the requirements of the NSW WHS Regulation 2011 for noise for the completed installation
- comply with any project specific requirements in the project Review of Environmental Factors
- not exceed an overall A-weighted sound pressure level of 85 dBA measured at a distance of one metre from any point on an individual item of equipment. Noise measurement must take into account background noise.

6.18.1 Noise measurement

Noise level testing will be:

- performed during FAT testing:
  - without acoustic enclosure fitted (if required)
  - with acoustic enclosure fitted
- performed during commissioning
- performed according to AS1217, AS1081 and AS3663
- recorded in ITP's and provided within 24hrs of the noise test.

6.18.2 Acoustic enclosures (soundproofing)

Equipment that cannot comply with the above noise requirements must be housed in a sound proof enclosure or building. Acoustic enclosures must:

- include air supply for equipment cooling
- include inlet air supply for equipment operation
- be constructed to allow full access for all maintenance tasks
- contain hinged panels to access components that require routine inspection or maintenance
- have acoustic insulating materials positively secured to prevent separation from the supporting cabinet. Glue is not acceptable as the only means of securing acoustic materials
- utilise sound proofing material with a minimum life of 10 years in the expected environment
- be fire proof and vermin proof

- not impede line of sight or access to emergency stop functions.

Buildings constructed as an acoustic enclosure must only contain equipment requiring acoustic enclosure, and not contain any other equipment, including electrical components such as switchboards, exceptions include local control panels.

6.19 Power transmission

6.19.1 Gear boxes

Design gearboxes in accordance with AS 2938 and AGMA standards.

Gear boxes must:

- be designed to operate continuously at maximum duty with a service factor that is based on maximum operating torque and the most conservative load classification for the drive in accordance with AGMA standards
- designed to withstand starting torques of up to 300% of the full load running torque of the driving motor as well as external loadings produced by thrust, out-of-balance and vibration resulting from operating conditions
- have lifting lugs to facilitate safe lifting
- have splash lubricated gears
- have oil level sight glasses with mechanical protection; sight glasses must be accessible from floor level
- have air breathers fitted
- have a magnetic drain plug
- have an oil filling port marked “fill” or be colour coded green
- have an oil draining port marked “drain” or be colour coded red, and:
  - able to have a waste oil container placed under the drain, this may require installation of a drain pipe
- be labelled with oil volume and type, in addition to general labelling requirements
- have the direction of rotation of input and output shafts marked or labelled permanently on the housing
- have guarding which allows access to the following points without the need for guard removal:
  - oil filler
  - oil drain
  - breather
  - oil level sight glass
- bearings can be either splash lubricated or grease lubricated. When grease lubricated bearings are fitted, install seals to retain the grease in the housing and configure in accordance with Lubrication
- use grade rated bolts to meet the design requirements. The grade rating must be marked on the bolt.

Gearboxes greater than 400mm in any dimension must:

- be constructed of cast metal
- have a ball valve on the drain line, with a threaded plug after the valve
- have two piece construction with a top cover for ease of inspection and maintenance

- have lockable ports, include dipsticks, oil drains and sample taps.

6.19.2 Flexible couplings

Flexible couplings must be of elastomeric compression or elastomeric shear type. Flexible couplings must be:

- rated to the torque under all loading conditions
- used where shafts have minor misalignment (radial, axial or angular)
- used where shafts have minor vibration
- installed within the flexible coupling manufacturers misalignment limits.

Flexible couplings must be designed to be sacrificial to protect shafts and attached equipment. Couplings must be commercial off the shelf items.

6.19.3 Chain couplings

Where chain couplings are used the chain must be high tensile chain steel.

6.19.4 Belt and chain drives

Belts and chain drive components must be standard commercial items stocked in NSW, this includes pulleys, belts, sprockets and chains.

Belt and chain drives must:

- have more than 120 degrees chain or belt wrap around the sprocket or pulley (Mott, 1999). Idler and tensioner sprockets or pulleys are exempted from this requirement
- be designed with a minimum service factor of 2 based on drive transmitted power
- be designed assuming motor starting torque must be at least 300% of motor full load torque.

6.19.4.1 Belt drives

Belt drives must have:

- a single cast pulley for multi-belt drives
- pulleys keyed to the shafts using a taper type locking hub.

6.19.4.2 Vee belts

Vee belts must:

- comply with the requirements of AS 2784
- use wedge type belts with SPA, SPB or SPZ sections
- have a maximum drive ratio of 3 to 1
- have at least two belts
- be matched belt sets from the same manufacturing batch
- have statically balanced pulleys and hubs for belt speeds below 25 m/s
- have dynamically balance pulleys and hubs for belt speeds above 25 m/s.

6.19.4.3 Chain drives

Chains must:

- be roller chains complying with ISO 606.

Sprockets must:

- have pinions with 19 teeth or more
- have the sum of the number of teeth on the pinion and wheel equal to 50 or greater
- be steel with hardened teeth, with hardness 360 Brinell or greater.

6.19.5 Stainless steel rotating machines

Machines with fabricated rotating stainless steel components must be fitted with a soft starter or VSD drives.

6.20 Pressure gauges

The pressure gauges must:

- have a maximum value that is no more than twice the maximum expected pressure
- be calibrated in kPa
- be constructed of stainless steel
- be bottom mounted, with a 10mm (3/8 BSP) threaded fitting and 10mm full bore ball valve
- be glycerine filled
- have face of minimum diameter 63mm
- have an isolation ball valve installed prior to the pressure gauge
- have an isolation diaphragm when fitted to chemical systems
- chemical pressure gauges must have a chemical resistant diaphragm to protect the pressure gauge.

6.21 Pressure pipes and pipe fittings

This section applies to pressure pipework and fittings associated with mechanical equipment. Pipework must be designed:

- to minimise pipe length
- with allowance of pressure de-rating to account for temperatures (atmospheric and pipe contents)
- to minimise the number of joins in a pipe run, with pipe lengths show on design drawings
- to allow for thermal expansion and contraction
- with dismantling fittings located for removal of serviceable items (E.g. pumps, flowmeters, injection lances), without the need to remove other equipment
- with air vent valves installed at high point of liquid lines
- with drains at low points to allow full pipe drainage

Pipe work must be installed:

- according to relevant Australian Standards and manufacturers' instructions
- with marking in accordance with AS1345, indicating pipe contents and direction of flow
- with pipe support, the pipe must not bear weight on machines, tanks and other connecting components
- to avoid springing of joints or induced stress
- with flanged thrust type dismantling joints
- without joins, where full pipe lengths can be used.

Pipes, fittings and sealing elements must be compatible with the contained material.

6.21.1 Pipe labelling

Pipe labelling for above ground pipe must comply with AS1345. In addition to AS1345:

- pipe that is not UV stable must be painted in accordance with AS 1345, refer materials section, new pipe must be UV stable
- the table below to supplement AS 1345 table 1 for clarity:

Colour name & basis identification	Pipe label background colour
Green	Recycle Effluent (on site use) Site re-use water Permeate
Silver-Grey	
Brown	
Yellow-Ochre	
Violet	Recycled water (to drinking water standard) as per WSAA Chemicals
Light Brown	Blower air
Black	Sewer up to commencement of primary treatment
Red	
Orange	
White	

6.21.2 Pipe flanges

Pipe flanges must comply with:

- AS4087;
- ANSI B16.5 for methane applications (1)

Pipe Flanges must:

- be bolted flanges for pipe internal diameter greater than 65mm
- be full circle flanges and not tabbed flanges:
  - Wafer lugged flanging will be accepted, where the lug is the full thickness of the fitting
- have mating faces machined and unpainted where pressures are greater than 500kPa
- have metal backing rings for non-metallic pipe
- be installed with flange bolt orientation to be off centre, to avoid a bolt being at the top dead centre position
- be attached to the pipe by casting, welding, or threading
- not be of the mechanically clamping type for pressure above 100kPa.
- be a minimum offset from walls and floors:
  - 200mm for pipe less than 300mm diameter
  - 300mm for pipe 300 to 600mm diameter

- 500mm for pipe greater than 600mm diameter.

6.21.2.1 Clamped and Crimped Pipe Adaptors

Flange adaptors are flanges that mechanically clamp to pipe. Flange adaptors must not be used for new works. Flange adaptors will be accepted for integration with existing assets, where the pipe either side of the flange adaptor is thrust restrained. Uni flanges can be used in place of Flange adaptor where there is not enough axial distance to install a Flange Adaptor.

Hydraulically crimped fittings can be used for:

- air pipework up to nominal bore 65mm
- water services up to 50mm services
- not for process pipelines.

6.21.3 Pipe fittings

Pipe fittings must:

- be full bore to match the pipe inside diameter (to limit pipe frictional losses). Exceptions include intentional flow restrictors, e.g. orifice plates.

6.21.4 Pipe anchorage (thrust & support)

Pipes must be anchored:

- to absorb static and dynamic thrust loads from pipes, fittings and valves; including during the operation of these fittings
- at all changes in pipe direction, including: tees, valves, tapers and termination points.

Pipe supports must:

- be galvanised steel or stainless steel for above ground applications
- be stainless steel where the pipe support is cast into concrete or submerged.

Pipes NB100mm or greater that pass through concrete walls will have cast in puddle flanges.

6.21.5 Threaded pipe

Threaded pipe must only be use with approval by Hunter Water.

6.21.6 Heat Tracing

Heat tracing of pipe must be installed in addition to insulation for small-bore pipelines (≤ 80 NB) where there is a risk of freezing or crystallisation of the fluid or embrittlement of the pipe.

6.21.7 Tracing Wire

Buried non-metallic pipes must be installed with a trace wire along their complete buried length. The tracer wire must be placed along the top of the pipe.

6.21.8 Pipe Materials

Table 6.3 below contains pipe materials suitable for the product to be piped:

Table 6.3 - Pipe Materials

		Exposed pipe			Buried pipe		
	Pipe size	**Up to 50mm**	**51-100mm**	**100mm and larger**	**Up to 50mm**	**51-100mm**	**100mm and larger**
Chemicals	Aluminium Sulphate	PVC-U	PVC-U	Project to seek HWC approval	PVC-U	PVC-U	
	Ammonia Hydroxode	PVC-U	PVC-U		PVC-U	PVC-U	
	Biocide	PVC-U	PVC-U		PVC-U	PVC-U	
	Carbon dioxide	PVC-U, SS316 seam welded	PVC-U, SS316 seam welded		PVC-U, SS316 seam welded	PVC-U, SS316 seam welded	
	Chlorine ejector water	PVC-U, Copper (as drawn)			PVC-U, Copper (as drawn)		
	Chlorine gas	MS to AS4041					
	Chlorine solution	PVC-U, PE	PVC-U, PE		PVC-U, PE	PVC-U, PE	
	Chlorine gas under vacuum	PVC-U			PVC-U		
	Citric acid (aqueous)	PVC-U	PVC-U		PVC-U	PVC-U	
	Methane (Digester gas)	SS316 seam welded	SS316 seam welded		SS316 seam welded	SS316 seam welded	
	Ferric/Ferrous chloride (iron salts)	PVC-U	PVC-U		PVC-U	PVC-U	

	Fluoride	PVC-U, SS316 seam welded	PVC-U, SS316 seam welded		PVC-U, SS316 seam welded	PVC-U, SS316 seam welded	
	Hydrochloric acid	PVC-U			PVC-U		
	Polyelectrolyte	PVC-U	PVC-U		PVC-U	PVC-U	
	Sodium bisulphate	PVC-C, PE	PVC-C, PE		PVC-C, PE	PVC-C, PE	
	Sodium hypochlorite	PVC-U	PVC-U		PVC-U	PVC-U	
	Sodium hydroxide	PVC-U, MS, SS316L	PVC-U, MS, SS316L		PVC-U, MS, SS316L	PVC-U, MS, SS316L	
	Sulphuric acid (concentraction <60%)	PVC-U	PVC-U		PVC-U	PVC-U	
Air	Aeration pipework <50degC (blowers)		PVC-U, SS316/ Spiral welded	PVC-U, SS316/ Spiral welded		PVC-U, SS316/ Spiral welded	PVC-U, SS316/ Spiral welded
	Aeration pipework >50degC (blowers)		SS316/ Spiral welded	SS316/ Spiral welded		SS316/ Spiral welded	SS316/ Spiral welded
	Agitation Air (grit agitation)	SS316 spiral or seam welded	SS316 spiral or seam welded	SS316 spiral or seam welded	SS316 spiral or seam welded	SS316 spiral or seam welded	SS316 spiral or seam welded
	Compressed air (to 700kpa)	SS316 seam welded, PE, Aluminium	SS316 seam welded, PE, Aluminium		SS316 seam welded, PE, Aluminium	SS316 seam welded, PE, Aluminium	
	Medical air	SS316 seam welded					
	Odour ducting			GRP			GRP

Process waste water treatment	Back wash discharge		SS316 seam welded or spiral welded, PVC-U,	SS316 seam welded or spiral welded, PVC-U, ductile iron (epoxy lined, bitumen coated)		SS316 seam welded or spiral welded, PVC-U, ABS	SS316 seam welded or spiral welded, PVC-U, ABS, ductile iron (epoxy lined, bitumen coated)
	Backwash supply		PVC-U	PVC-U		PVC-U, Stainless steel, PE	PVC-U, Stainless steel (seam or spiral welded), PE
Clean Water	Potable	Stainless steel (seam welded), PVC-U	Stainless steel (seam welded), PVC-U		Stainless steel (seam welded), PVC-U, PE	Stainless steel (seam welded), PVC-U, PE	
	Industrial (non-potable)	Stainless steel (seam welded), PVC-U	Stainless steel (seam welded), PVC-U,		Stainless steel (seam welded), PVC-U, PE	Stainless steel (seam welded), PVC-U, PE	
	Fire Main	Copper	Copper, SS316 seam welded or spiral welded	SS316 seam welded or spiral welded	Copper	Copper	SS316 seam welded, Ductile Iron
Secondary Sewage	Mixed Liquor		PVC-U	PVC-U		PVC-U, ABS	PVC-U, ABS
	Supernatant/ Subnatant		PVC-U, PE, SS316	PVC-U, PE, SS316		PVC-U, PE, ABS, SS316	PVC-U, PE, ABS, SS316
Sludge	Digested Sludge		SS316, PVC-U, PE	SS316, PVC-U, PE		SS316, ABS, PVC-U, PE	SS316, ABS, PVC-U, PE
	Raw Sludge		SS316, PVC-U, PE	SS316, PVC-U, PE		SS316, ABS, PVC-U, PE	SS316, ABS, PVC-U, PE
	Thickened Sludge		SS316, PVC-U, PE	SS316, PVC-U, PE		SS316, ABS, PVC-U, PE	SS316, ABS, PVC-U, PE
	WAS		SS316, PVC-U, PE	SS316, PVC-U, PE		SS316, ABS, PVC-U, PE	SS316, ABS, PVC-U, PE

Miscellaneous	Filtrate		SS316, PVC-U, PE	SS316, PVC-U, PE		SS316, ABS, PVC-U, PE	SS316, ABS, PVC-U, PE
	Grit Slurry		SS316 seam welded	SS316 seam welded		SS316 seam welded	SS316 seam welded
	Off spec permeate	SS316, PVC-U	SS316, PVC-U	SS316, PVC-U			
	Reclaimed effluent	SS316, PE, PVC-U	SS316, PE, PVC-U	SS316, PE, PVC-U		SS316, PE, PVC-U	SS316, PE, PVC-U

6.21.8.1 Acrylonitrile Butadiene Styrene (ABS) Pipe

ABS pipes must:

- comply with AS 3518
- be painted when exposed to sunlight

6.21.8.2 Carbon Steel

Carbon steel pipe must comply with AS1074, AS1579 and AS4041.

6.21.8.3 Copper Pipe

Copper tube must:

- comply with AS 1432
- be seamless
- have silver solder joints
- comply with AS 4809
- be insulated from steel or cast iron pipe
- be insulated from supports.

Fittings on copper pipe must comply with AS 3688.

6.21.8.4 Glass Re-enforced Plastic Pipe

GRP must:

- comply with AS 3571.

6.21.8.5 Mild steel pipe

Mild steel pipe must comply with AS1074, AS1579.

6.21.8.6 Polyethylene pipe

Polyethylene pipes and fittings must:

- comply with AS 4130 and AS 4129
- be minimum pressure rated PN16
- be continuously support (E.g. cable tray) to avoid pipe sag.

Polyethylene has approximately 3 times the thermal expansion co-efficient of PVC, making is less suitable for outdoor installations.

6.21.8.7 Polyvinyl Chloride pipe

PVC pipes must:

- comply with AS1477
- be jointed according to AS3879
- be a minimum of class 18
- be used in applications under 60 degrees Celsius
- be painted or clad when exposed to sunlight.

6.21.8.8 Stainless steel pipe

Stainless steel pipe work must:

- be grade 316L
- seam or spiral welded
- have welds cleaned, pickled and passivated.

Spiral wound pipe must have a minimum thickness of 3mm.

6.21.9 Pipe couplings

Flexible pipe couplings must be the self restraining type. Pipe thrust must be less than the restraining capacity of the flexible pipe coupling.

6.21.10 Seals on rotating elements

6.21.11 Seal selection – process liquids

Seal selection for pumps and rotating submerged equipment must consider:

- operational requirements and the down time required to replace the seal
- maintenance cost to replace the seal, including access and lifting
- operating conditions and be fit for purpose.

Gland packing or split case seals must be used where equipment can have limited down time or has a better LCC outcome.

6.21.12 Gland seals

Gland seals must:

- be used where there is a risk of pump/motor misalignment
- be used where stuffing box pressure/vacuum will be unpredictable
- have a wear sleeve on the shaft
- use graphite impregnated packing or use packing that is compatible with gland wearing sleeves (e.g.: graphite lubricant reacts with stainless steel).

6.21.13 Mechanical seals

This clause does not apply to submersible pumps and mixers.

Mechanical Seals selection and installations must:

- have stationary seals (stationary seals are not sensitive to misalignment between the pump and the motor and other forms of shaft deflection)
- be non-propriety to a specific manufacturer
- not be retro-fitted to equipment originally designed with gland packing
- not use split design seals.

Mechanical seals must:

- be balanced type, cartridge mounted seals with large bore seal chambers that provide increased seal life and improved cooling of seal faces. Tapered seal chambers are preferred. For liquids containing solids, provide suitable deflectors to keep solids and air away from the seal face;
- have bellows or multiple, helical springs and “O” rings
- have seal faces lapped flat to within two (2) helium light bands and the depth of interface roughness not exceeding 0.3 microns
- have seal faces which remain safely below the vaporisation temperature under operating conditions
- not have carbon or ceramic faces
- either be separated by an oil bath or interface if used as a set of two single mechanical seals, or be of double shaft type.

6.22 Services routing

Services must be routed/installed in service corridors. Service corridors must be applied when two or more services can be grouped and installed on a common route. The intent of service corridors is to provide safe, unobstructed access to services for operation and maintenance, while have the least impact on movement around the site.

These service corridors must:

- be designed to allow clear access to all equipment for operation and maintenance
- ensure walkways are unobstructed; where services traverse walkways, the services must be aggregated in a single step pedestrian platform
- be sized based on the quantity of services
- be self-draining
- have electrical services installed at higher levels than fluids, wherever possible
- have individual services installed in order of potential contamination, with cleanest at the top and most contaminated at the bottom. Services include, in contamination order (nominal):
    - control and instrumentation cabling
    - power cabling
    - potable water
    - blower air
    - compressed air
    - odour control ducts
    - recycled water

  - chemical dosing
  - process water (diameter less than 100mm)
  - drainage
- space services to allow maintenance access and comply with relevant standards
- make allowance for future services to the extent of current site master plan, where one exists.

Above ground services must be installed:

- on walls of structures, or
- on a pipe rack, consisting of a corridor of columns around equipment to mount services.

Below ground services must be installed in accessible service corridors, meeting the requirements above. Where services are mounted in a culvert, the culvert must have:

- services mounted on the walls, not on the floor
- covers load rated for expected loads
- road crossing covers.

Designers and installers may put forward alternative arrangements for installation of services in service corridors, which meet the intent of the requirements above.

6.23 Special tools

The Contractor must provide any specific tools or jigs for maintenance, repair, overhaul and operation of the equipment. Special tools must:

- have a minimum of two sets provided per Hunter Water site
- be in new and unused condition
- be supplied in individual lockable tool boxes that are clearly marked to indicate the equipment to which they apply.

6.24 Surface preservation (coatings)

Clause to be omitted in current version and added at a later date when HWC had paint spec in place.

Surface coatings, including galvanising and painting must comply with WSA201 Manual for the Selection and Application of Protective Coatings.

Where surfaces have been coated or preserved (including painting or galvanising), they must be restored as per the Hunter Water Protective Coating standard in the event any work is carried out, such as site modification.

7 Equipment Specific Considerations/Requirements

This section sets out the mechanical requirements for specific equipment. Process capability and function are outside the scope of this document.

For equipment three aspects have been considered: equipment design considerations; plant design considerations (installed design); and equipment installation considerations:

- equipment design considerations addresses items that must be considered at the design and fabrication stage for equipment
- plant design considerations (installed design) addresses items that the plant designer must consider when designing the equipment into the plant
- equipment installation considerations addresses considerations when installing equipment.

7.1 Actuators

Permanently installed actuators must:

- comply with ISO 5211
- be rated for continuous operations
- be sized to provide the maximum torque at 90% of the normal voltage
- be able to operate in any mounting position
- be self-locking, in the last driven position
- have a hand wheel for manual operation.

7.1.1 Portable actuators, for penstocks and valves

Portable penstock and valve actuators must:

- be designed to manage torque, without a need for the operator to absorb torque
- be positively held in place
- weigh less than 15kg
- be safely operated by one person, and
- be IP66 rated.

7.1.2 Actuators with fail safe

Fail safe functions on actuators must be by the following method to change the valve position:

- mechanical spring for low actuation frequency, less than 10 cycles per day
- hydraulic, pneumatic or UPS for high actuation frequency control equipment.

7.1.3 Pneumatic Valve Actuators

Pneumatic valve actuators must:

- be double acting type
- have integrated open and closed limit switches
- have adjustable limit switches to accurately sense the correct valve position
    - Part turn actuators must have adjustable travel stops.

7.2 Blowers

This clause applies to blowers installed for submerged aeration applications.

Air blower technologies have different bearing types, including contract bearing, magnetic bearing and air foil bearing. Screw hybrid type blowers can be combined with magnetic bearing or air foil bearing type machines. Positive displacement lobe type blowers must not be combined with magnetic or air foil bearing machines.

Blowers must:

- have 40% turndown of is maximum output flow rate
- be able to operate with ambient inlet air temperature -10 to 50 degrees
- be able to operate at it's maximum duty continuously
- be mounted in an acoustic enclosure
- be controlled by the site PLC and a Hunter Water approved VSD.

Blowers must be installed with the following minimum ancillary equipment:

- discharge pressure transmitter
- actuated discharge bypass (or blow off) valve, the bypass valve must be sized for full flow of the blower. The discharge from the bypass valve must be directed safely to the atmosphere, outside the blower room and fitted with a silencer
- discharge isolation valves
- discharge reflux valve located upstream of the isolation valve. The reflux valve must be located in the pipework to prevent fall back of parts into the blower
- discharge silencer to minimise noise transmission to the aeration pipework
- blower monitoring sensors with their display mounted outside any acoustic enclosure
- vibration absorbing mounts
- air temperature monitoring within the discharge pipework
- air temperature monitoring within the acoustic enclosure
- differential pressure monitoring across the inlet air filter, which will raise a SCADA alarm to clean/replace the inlet air filter
- flexible pipe connection to fixed outlet pipework, and inlet where plumbed
- pulsation dampers, where the blower type produces pulsation in the discharged air. The pulsation damper must eliminate pulsation noise and vibration.

Blower room/building must:

- be dedicated to blowers, with no other equipment in the room
- exhaust blower cooling air direct to the open atmosphere, outside the blower building
- have the exhaust discharge:
  - acoustically treated to avoid blower noise to the atmosphere
  - weather protected to avoid water ingress
- have air inlets filtered to match the blower inlet air hygiene requirements
- have air filters accessible from ground level, for access & cleaning
- be ventilated to limit the temperature rise in the room to less than 10 degrees Celsius above ambient air temperature
- have acoustic vents, air inlets and filters.

7.2.1 Blower specification

Procurement of blowers must be based on lifecycle cost and include a net present value estimate. The blower energy usage must be based on the blown air daily diurnal pattern for the 50 percentile day. ~~Blower suppliers must provide the energy usage by the blower for the 24 hour period for the 50 percentile day.~~

7.3 Clarifiers (circular)

This clause relates to circular clarifiers used for separate of sludge & scum from wastewater.

Clarifiers must be column supported type with:

- fixed (non-rotating) bridge
- any rotating elements below the bridge and separate to the bridge
- drives for rotating elements above water and fully accessible by maintenance platforms
- Wall height 1m or greater.

Existing clarifiers that have rotating bridges, must have:

- guarding of the circular path of the bridge, this must be man proof fencing around the clarifier gantry path
- nudge bars for elements on the clarifier wall and outside the clarifier wall. The nudge bars must stop the clarifier gantry and raise a SCADA alarm
- drive gearboxes located outside the clarifier wall or have a drip tray that directs oil outside the clarifier wall.

7.4 Combustion engines (petrol/diesel)

Machines with combustion engines must comply with AS4594 and AS 3009, in addition they must be designed:

- to run under operational load or an equivalent load for a minimum of 4 hours each month (this may require a load cell or similar)
- to have a single fuel tank sized to store fuel for a minimum of 4 hours operations under full load
- to include a fuel filter on the outlet side of the fuel tank
- to include a fuel level site glass
- with a fuel tank breather to open atmosphere. Breather cannot release to an enclosed space
- with a lockable tap that allows for full draining of the fuel tank, to drain stale fuel and settle material
- to include a drip tray that has 1.5 times the volume of the oil & full fuel capacity, to contain any oil or fuel leak from the engine. When a drip tray cannot be incorporated into the engine, the engine will be installed in a bund complying with Hunter Water STS670
- to be operated outdoors (weather proof).

Combustion engines with fuel storage capacity of 60L or greater must include:

- stainless steel or polyethylene fuel tank
- fuel tank off take, min 30mm from bottom of tank (for draining stale fuel).

Combustion engines must be installed with:

- clearance for 6m from combustible material and vegetation, to avoid grass & leaf litter contacting the engine

- a truck delivery bund for the fuel delivery truck
- exhaust to external atmosphere
- the exhaust to be weather proof
- security measures to prevent vandalism
- Hunter Water keys on cabinets or panels, where locks are fitted.

7.5 Compressed air systems and associated components

Compressed air systems must:

- be designed for pressure drop in the lines to be less than 15kpa, from compressor to air supply point
- have an automatic drain tap on compressed air pipe work. The drain tap must be:
  - located at the lowest point of the air system
  - piped to the site wastewater system. Drain water must not traverse walkways, where it can generate a slip hazard
  - installed with a hardwired power supply for electrically driven drain valves
- utilise single air receivers for multiple compressors
- have air receiver capacity which results in up to 6 compressor starts per hour (combined with the compressor output at 50% duty cycle)
- capture all automatically drained by-products (e.g. water and oil)
- include air coolers to match the requirements of the air actuated equipment
- minimise serviceable network components
- match air quality requirements to equipment requirements. If instruments and other equipment are fed by the one compressor, separate air dryers may be required for each air quality requirement where the air quality requirements differ. E.g. instrument air quality air for standard actuators will reduce the life of the actuator
- isolate vibration of the compressor or air dryer from the fixed pipe network.

Commissioning of compressed air systems must involve:

- tests to measure system pressure drop over time to quantify system leakage
- measurements to chart pressure and flow rate over all operating scenarios
- ultrasonic leak detection 3 months after commissioning. Leaks must be rectified.

7.5.1 Compressor

Compressors must:

- be installed with redundancy suitable for the process requirement:
  - compressors supporting continuous processes must have a minimum duty/standby arrangement
  - compressors supporting ancillary equipment operated intermittently can be single duty arrangement
- have capacity 300% of peak air demand
- have oil reservoir with oil level sight glass and filter
- have an air intake filter:
  - with less than 15kPa pressure loss across the air filter
  - that removes material greater than 0.01 microns

    - with differential pressure measurement across the filter. The pressure differential must be monitored and generate an alarm in SCADA
- intake cool air to maximise compressor efficiency, this may require ducting away from the machine or room to source cool air
- position external air intakes to prevent ingress of rain, aerosols and sea spray
- have an unloading system for ease of starting
- have the monitored safety features:
    - low air inlet pressure
    - high air discharge pressure
    - low oil pressure.

7.5.2 Air dryers

Air dryers on compressor systems must:

- be installed with a minimum duty standby arrangement
- have their dew point set 10 C below the lowest expected temperature at that location. The dew point must be adjustable for summer and winter conditions
- be site adjustable for dew point by Hunter Water operator
- be selected to match the operating conditions, i.e. refrigerant dryer vs desiccant dryer vs other technology
- separate moisture and have an automatic moisture drain
- have indication of equipment failure
- have manual override or bypass
- be independent equipment (not integrated with compressor).

7.5.3 Air lubrication

Compressed air lubrication systems must:

- be designed to match the requirements of the equipment supplied by the air system
- feed only to those air using components on the system that require lubrication
- use lubricators that:
    - can be refilled while “online” by an operator
    - have a fill level sight glass
- have lubricators located where they cannot spill/leak into processes, do not place above open process tanks or channels
- be accessible without removal of guards or machine dismantling.

7.5.4 Compressed air pipework

The compressed pipe pipework:

- must be based on a ring main and branch design
- can be oversized to provide network air storage
- pipe materials are addressed separately in this specification.

A ring main pipe network (closed loop) must be considered, taking into account the following factors:

- high demand users
- length of network

- flow rate of air in main at compressor outlet.

Compressed air pipework must:

- have allowance for thermal expansion/contraction, can be achieved by “pigtail” loop in pipe
- have a minimum 1 in 100 fall in the direction of air flow towards a drain point
- be sized to match the maximum air demand point
- have the pipe diameter from the compressor to the receiver equal to or greater than the compressor outlet
- have local air service units to meet localised air quality requirements
- have local air service units shielded from UV exposure
- have automatic moisture drain valves, which drain on a timed basis
- have moisture drains fitted with a silencer
- have drain points (auto or manual) piped to site wastewater system
- have flexible metal braided couplings to the compressor and dryer to isolate vibration
- be anchored according to the pipe manufacturers recommendations
- have isolation valves for maintainable/serviceable components
- be accessible, and not encased
- have flanges for pipe and fitting connections. Threaded pipe ends must not be used.

Compressed air pipework branching off the ring main must:

- take off the top of mains
- have isolation valves at the take off points
- have pressure release valves on each branch, to make safe for maintenance
- have nameplate with the pressure release set point
- be configured with branches for equipment requiring air quality different to the air quality after the air dryer
- have branch lines from the main for process units with 2 or more air demand points.

7.5.5 Air Receiver

Air receivers must comply with the requirements for pressure vessels in STS650.

The inlet and outlet diameter of the air receiver must be equal to or greater than the outlet diameter of the compressor.

Remote air receivers or oversized pipework must be considered on long distribution networks, where it is more than 100m from main receiver to high demand equipment.

7.6 Conveyors and associated components

Conveyors must comply with AS1755.

General requirements of solids transporting systems:

- all surfaces of the conveyor system that will come into contact with conveyor must be free of sharp edges and projections. This includes the conveyor components, receiving and discharging components
- couple conveyors directly to the receiving machine, where the receiving machine is designed to have conveyors directly coupled, without a discharge chute
- feed and discharge chutes must:

- allow clear passage of material, without blockage or hang-up of material
- be vertical or pyramid type (getting wider as they descend)
- have air tight inspection doors

7.6.1 Conveyor - belt

Belt conveyors must:

- comply with Australian Standards
- be belt width 600mm
- have the drive pulley located at the lower end on inclined conveyors
- have maximum inclination to horizontal of 20 degrees
- have lagged drive and idler end pulleys
- have the top of the belt supported by 2 idlers in a “V”. Idlers must be 341mm long
- have heavy duty slurry rollers, fabricated roller with sealed bearings or plastic rollers with sealed bearings. Rollers must not be pressed sheet metal roller type
- have belt end joined by vulcanising
- have motion sensors fitted at the non drive end. If this is the tensioning end the sensor must be mounted to move with the pulley end and configured to stop the machine and generate an alarm in the event of motion ceasing at the non drive end
- be cleanable by hose, without the need to remove guarding.

7.6.2 Conveyor – screw

Screw conveyors are suitable for grit, wet screenings, dry screenings. Screw conveyors are not suitable for conveying dewatered sludge.

Screw conveyors must:

- push product away from the motor end
- have maximum speed 15rpm when installed horizontally
- have maximum speed 20rpm when installed inclined to horizontal
- have maximum length of 11m
- have minimum auger diameter of 280mm, maximum 350mm
- have shaftless continuous ribbon type screw
- have screw pitch selected to convey material of the specified moisture content and composition
- be top feed only
- have drain point/s at the low end of the trough
- include replaceable wear liners with wear indicators
- have an emergency discharge outlet, located after the discharge to the receiving machine
- have an electric motor drive with:
  - a directly mounted reduction gearbox
  - electronic torque protection
- have bearing at the drive end taking axial and thrust loads, and no idler end or intermediate bearings.

Screw conveyor installation/system design must:

- make allowance for extraction of the auger in one piece from the screw conveyor trough
- limit conveyer inclines to a maximum of 30 degrees to horizontal

- have drive motor and gearbox in an accessible location
- have conveyor drives accessible by:
  - permanent access platform, or
  - by an Elevated Work Platform, the design drawings must show where the platform will be located
- include a “park position” for slewing conveyors, this must be adjacent to permanent access where applicable
- transfer product between screw conveyors by dropping vertically. Product must not feed into the side of the receiving conveyor
- include weather proof (rain proof) covers for outdoor conveyors, to stop rain landing on the product side and return side of the belt
- include inspection ports at intersections with other equipment and other conveyors. These ports must be designed and sized for inspection and clearing blockages.

7.6.3 Conveyor – Sluices (launder)

Sluices are suitable for conveyance of wet screenings. Sluices work best when installed in conjunction with screenings dewatering machines that include a wash function.

Sluice design must:

- accommodate a decline of 2-7 degrees from horizontal
  - be adjustable within this 2-7 degree range
- allow for final sluice angle to be set during commissioning
- have water sprays at the head end of the sluice to ensure the conveyance of all screenings along the sluice
- have solenoid controlled valves which activate the spray nozzles when the screenings entering the sluice, the run time of the spray nozzles must be programmed during commissioning
- operate using recycled plant water for sprays nozzles, which may contain suspended solids
- have an emergency discharge outlet, located after the discharge to the receiving machine
- be uncovered
- be fabricated from Stainless Steel
- specify the pressure, flow and spray water quality required.

Sluice plant design must:

- accommodate a decline of 2-7 degrees from horizontal
- be adjustable within this 2-7 degree range.

Note: Shortland WWTP sluice is at 2.75 degrees, Toronto WWTP Sluice is at 5 degrees.

Sluice installation must:

- have final sluice angle set during commissioning.

7.7 Flame Arresters

Flame arresters must:

- be self-draining to waste streams
- have isolation valves, to allow removal of the flame arrestor
- have permanent maintenance access.

7.8 Grit System Handling Equipment

The grit system must have the following features:

- minimise length of grit pipe (suction & delivery)
- allow access to grit pipe work for clearing chokes
- step down in the diameter of the suction pipework immediately prior to the pump
- rodding points on the suction and delivery pipework
- tee on pump suction line with isolation valve and 100mm quick release type fitting (e.g. camlock) for connecting vacuum truck
- water sparge line configured with tee to allow supply of air to grit chamber
- man access/platforms for use of rodding points.

7.8.1 Grit Paddle

The grit paddle must be designed to allow scouring of the bottom of the grit chamber, without needing to remove the grit paddle. One way this can be achieved is with ports in the paddle of 200x200mm or 200mm diameter (minimum dimensions).

7.8.2 Grit Pump

Grit pumps must be installed with a flooded suction.

7.8.3 Grit Classifiers

Grit classifiers dewater grit slurry. Grit classifiers must comply with guarding requirements of this document, including:

- interlocks to eliminate the risk of personnel injury
- prevent the risk of crush injury whilst on the access platform
- removable panels are interlocked to shut the machine down if it is removed.

Where Bache grit classifiers are installed they must have access platforms and guarding to allow operators to view the pan/trough on one side when the classifier is operating.

7.9 Mixers

7.9.1 Inline (in pipe) static mixers

Inline static mixers are installed in pipes to create turbulence, to mix injected chemicals. The mixer must:

- be made of stainless steel
- have a pressure rating consistent; with the pipeline
- have a degree of mixing, measured in terms of Coefficient of Variation (CoV) achieved by the static mixer of lower than 0.05 in less than 5 seconds over the full flow range
- have a performance curve submitted for approval prior to installation.

7.9.2 Submersible mixers

Submersible mixers must:

- be designed for continuous operation
- be adjustable for depth and mixing direction
- be direct drive, with the impeller mounted on the motor shaft
- include moisture probes to detect seal failure
- include a moisture detection in the motor stator housing and cable termination housing.
- be mounted on a minimum 100x100mm section stainless steel guide rail
- be removable without personnel entering the tank or water body
- have a davit for removal with stainless steel lifting mechanism (chain or wire rope)
- include a load rated lifting chain, the lifting chain must:
  - be continuous
  - be stainless steel
  - have a stainless steel lifting eye, min 100x150mm, at the top to accept a crane hook
  - have second stainless steel lifting eye, min 100x150mm, 1.5m below the top eye

7.9.2.1 Submersible mixers (potable water)

Submersible mixers in potable water applications must:

- have a stainless steel impeller or non-metal impeller
- be adjustable to adjust the direction of the mixer to optimise mixing.

7.9.2.2 Submersible mixers (wastewater)

Submersible mixers in wastewater applications must:

- have an open impeller that is self-clearing of rag
- not have a shroud or thrust rings around the impeller (as they gather rag).

7.10 Odour extraction systems

7.10.1 Odour extraction ducting

Odour extraction ducting must:

- be stainless steel or GRP
- not be spiral welded stainless steel for aerosols containing Hydrogen Sulphide
- self-drain condensation back to waste streams or systems. Condensation must not drain to the odour treatment system.

7.10.2 Odour fans

Odour fans must:

- have coupled drive, such as V-belts, not have motor and impeller direct coupled on the one shaft
- have a damper immediately upstream to stop “leakage” when not operating
- have a brake to stop reverse rotation. The brake must be:
  - integral to the motor
  - disc brake type

  - 415V supply
- be connected to the ductwork by a flexible connection to isolate fan vibration from the ductwork, this applies to inlet and outlet of the fan
- have non-return dampers to prevent backflow, when connected to ductwork in parallel ductwork.

7.11 Penstocks, stop boards, adjustable weirs

7.11.1 Penstock, stop board, adjustable weir frames,

Penstock, stop board and adjustable weir frames must:

- be embedded into channels, finishing flush with channel sides and invert
- be mounted on the upstream face of walls, when the frame is mounted in an opening of a wall
- have a leakage rate past the seal less than 200ml per metre, of submerged perimeter seal
- have seals designed for fitting in ”c” section channel (Uni-strut or similar)
- have vertical seals that are replaceable with the penstock frame in situ
- have manual hand wheels located between 800 to 1100mm from the surrounding surface to the centre of the hand wheel
- have provision for connection of lifting equipment.

Where position monitoring is required, inductive proximity switches must be used for indication of both open and closed position. Mechanical limit switches are not acceptable for this purpose.

7.11.2 Penstocks

Penstocks must:

- clear the flow when fully open by a minimum of 100mm.

Penstocks design must:

- be fabricated from stainless steel
- be able to open and close under unbalanced loads
- have rising spindle
- have a lock for the fully open and fully closed position. The lock mechanism must be tamper proof
- have support brackets for spindles, greater than 1.5m length
- have permanent actuation when called automatically by the site control or is used 3 monthly
- have fittings for portable actuation when permanent actuation is not required
- have permanently installed actuators securable and tamper proof, where installed
- allow the gate to be completely removed from the frame
- have a transparent weather cover over the rising spindle.

7.11.3 Stop boards

Stop boards are used to isolate flow in channels.

Stop board must be designed:

- to be handled, installed and removed by one person. Where this requirement cannot be met permanent lifting and handling devices must be provided with certified lifting lugs
- for removal without removing grating or handrails (safety equipment) or other installed equipment
- with maximum deflection of 1 in 500 across the channel width
- be fabricated from:
  - stainless steel, when the stop board will normally be partially or fully submerged
  - stainless steel or aluminium, when the stop board is normally away from the process fluid
- with a chamfered leading edge, providing a narrow leading edge, to seat against the seal at the bottom of the channel
- to have maximum leakage rate of 200ml per metre of stop board seal, for the perimeter seal of the stop board
- to be bi-directional or have the high pressure side marked on the stop board.

Stop board plant design must:

- include a designated storage location for stop boards in the vicinity of its frame.

7.11.4 Adjustable weirs

Adjustable weirs must be:

- isolatable for maintenance
- proved and functionally checked during commissioning.

7.12 Pumps General Requirements

7.12.1 Pump supply and documentation

This section sets out the lifecycle principles for pumps at Hunter Water.

7.12.1.1 Factory Acceptance Testing

Provide 21 days notice of despatch of equipment to site, so that FAT can be conducted prior to leaving the supplier.

Hunter Water may perform FAT on pumps which:

- are process critical
- are unique
- are new to Hunter Water's fleet of equipment
- or at Hunter Water's request.

7.12.1.2 **Testing**

Pump test according to AS/ISO9906, as follows:

Pump motor size	
Water pump	
<11kW	AS/ISO 9906 section 4.4.2
11 to 50 kW	AS/ISO 9906 grade 2B
>50 kW	AS/ISO 9906 grade 1B
Sewer pump	
<11kW	AS/ISO 9906 section 4.4.2
11 to 50 kW	AS/ISO 9906 grade 3B
50 to 100 kW	AS/ISO 9906 grade 2B
>100 kW and made to order	AS/ISO 9906 grade 1B

Pumps with variable speed drives must be tested at different speeds so that a performance curve can be generated. The pump test must be:

- performed for pumps with motor 30kW or greater
- at a minimum of five different speeds approximately equally spaced from the minimum to the maximum for the duty range
- with the motor the pump will be installed with.

Submit test certificates and result sheets for performance tests 14 days before the pumps leave the factory.

(The categories for pump testing is based on the following reasoning:

- energy usage is higher in larger pumps, so the extra cost of more accurate measuring of pump performance (efficiency) is justified on larger pumps
- sewer pumps typically run less hours than water pumps, so absolute energy usage is lower and lower efficiency pumps are often deliberately selected for sewer applications due to their ability to cope with the type of product, so spending more on testing is not justified)

7.12.2 Commissioning

During commission of pumps record:

- flow rate, head, suction and delivery pressure, motor speeds and power to plot performance curves
- for self priming pumps
  - vendors theoretical time to prime
  - actual time to prime and reach duty point, starting with suction pipe empty, perform 3 times.

Pump commissioning must be witnessed by a Hunter Water Mechanical Engineer.

7.12.3 Drawings and Documentation

7.12.3.1 Drawings

Pump and pump system drawings must be supplied for all equipment to be installed after completion of detailed design and prior to installation, for acceptance.

Pump drawings are acceptable in the OEM format, in English language.

7.12.3.2 Pump Curves

Pump curves must include:

- head
- flow and efficiency
- specific energy consumption
- pump speed
- NPSHR
- power (shaft power and rated power)
- impeller code
- impeller diameter
- inlet flange size and table
- discharge flange size and table
- pump identification: make, model, serial number.

7.13 Pump System Requirements

7.13.1 General Requirements

The pump system components must be able to withstand hydrostatic pressure testing at 1.5 times the maximum allowable working pressure.

Pumps must operate satisfactorily without exceeding a current in any motor cable equivalent to 95% of the motor maximum continuously rated (MCR) current under the specified supply conditions.

7.13.2 Pump Configuration

7.13.2.1 Parallel Operation

Parallel pumping applications require pumps that can operate as a single pump or in parallel. The pump must maintain stable operation under all conditions (i.e. single or parallel operation).

7.13.2.2 Series Pumping

Series pumping should only be considered where an appropriate multi-stage pump cannot be identified.

7.13.2.3 Header Pipes (manifolds)

Where header pipes are used for pump stations, the header pipe and fittings must be installed to allow pump removal without affecting the operation of the remaining pumps.

7.13.2.4 Suction Pipe Requirements

Suction pipes must:

- have the minimal number of pipe fittings and features (to reduce head loss and risk of air ingress)
- take into account the requirements of the selected pump
- be the same size as the pump inlet or greater.

7.13.3 Delivery Pipe Requirements

Where multiple pumps or pump stations deliver to a common delivery pipe at the same time hydraulic modelling must be performed. The modelling must identify issues that would reduce the performance or operational life of the pumps and make recommendations to eliminate the issues.

7.13.4 Pressure Tapping Points

Pressure tapping points must be:

- fitted on the delivery side of pumps:
  - on a length of straight pipe a minimum of 5 pipe diameters from a point of disturbance;
- fitted to suction pipe for dry mounted pumps with suction line 10m or greater
- fitted to the top of pipes
- fitted with a stainless steel ball valve, minimum size of 3/8 inch BSP(T).

7.13.5 Strainers

Strainers must be installed upstream of piping components with small orifices. Piping components with small orifices include:

- solenoid valves
- needle valves
- control valves, including: pressure reducing valves, pressure sustaining valves, automatic inlet valves.

Strainers must have isolation and access for cleaning. Strainers on pipework larger than 100mm diameter must have a drain.

7.13.6 Static Mixers

Static mixers must be fitted with a tapping point at the inlet and outlet for measurement of pressure drop.

7.14 Pump Requirements

7.14.1 Requirements for all Pump Types

7.14.1.1 General Requirements

Supply pumps that:

- are suitable for continuous and intermittent operation at the specified operating range
- have a pump head/flow curve that rises continuously towards shut off head (i.e. zero flow). Pumps with unstable performance curves are not acceptable
- maintain stable operation at all discharge pressures
- have the normal design flow rate at 90 to 110% of the best efficiency point/optimal operating point
- have the direction of rotation clearly and permanently marked on the pump body
- are fitted with bridles, eyebolts or lugs for safe lifting and handling (for pump/motor assemblies greater than 20kg)
- have rigid footings that maintain pump and motor alignment during operation and are bolted to the equipment bed
- have a minimum design life as defined below:

Pump type	Minimum design life (Years)
Potable Water 0-22 KW	15
Potable Water 22-50 KW	20
Potable Water >50KW+	30
Sewer pumps	15
Chemical pumps	10
Other pumps	Project specific specification

7.14.1.2 Pump Casing

The pump casing must:

- be designed such that components in the pump casing that are subject to wear are easily removable for refurbishment or replacement.

7.14.1.3 Motors sizing

Pump motors must be sized a minimum 5% larger than the peak power requirement of the selected pump curve. The process for motor sizing must include selection of the pump, the impeller and the operating speed, identification of the maximum power input required for these conditions, with the addition of 5% to maximum power requirement to define the minimum motor size.

Motors must be rated for maximum continuously rated duty.

7.14.1.4 Pumps Driven by Variable Speed Drives

Where a pump is installed with a VSD:

- the VSD must match the load characteristic of the type of pump
- the NPSHA must exceed the NPSHR over the specified operating range by a minimum 135% of the NPSHR or 1m, whichever is greater
- consideration must be given to an independent motor cooling fan when a motor will be operated at less than 50% motor speed for extended periods, if a directly coupled fan would not provide sufficient cooling at the slower speeds.

7.14.1.5 Pump Speed

Pump speed must be 1500rpm or less (4 pole motor). Pumps with speed greater than 1500rpm will be considered if:

- a lower lifecycle cost can be demonstrated, or
- if a pump with a 4 pole motor cannot meet the duty within -20% to +10% of flow rate from the BEP.

Pumps must not operate above 50Hz.

7.14.1.6 Drive Mechanism Protection

Electric motor driven pumps must be installed with electronic overload protection. Pump suppliers must provide overload protection requirements (e.g. type, make, model, etc.) and the load at which the device needs to stop the equipment to prevent damage to the motor.

7.14.1.7 Pump Foundation

As a general rule concrete foundations should be:

- 5 times the mass of the pumping equipment for centrifugal pumps
- 10 times the mass of the pumping equipment for reciprocating pumps.

7.14.2 Centrifugal Pump General Requirements

This section sets out requirements for centrifugal pumps.

7.14.2.1 General Requirements

Centrifugal pumps larger than 30kW (nominal) must have split case volutes, excluding submersible pumps and dry mounted submersible pumps.

7.14.2.2 Impellers

Centrifugal pump impellers must:

- have the highest efficiency for the selected pump with consideration of:
  - the pump specific speed
  - the fluid being pumped
  - the specific application
- be fixed to the shaft so that they cannot come loose, including reverse rotation.

The pump supplier must provide life-expectancy information for coatings or polish applied to the impellor to improve efficiency.

7.14.2.3 Pump Shaft

The pump shaft first lateral critical speed must be a minimum of 150% higher than the maximum pump design speed.

Calculate critical speeds using the following assumptions:

- the largest impeller that will fit in the pump case
- disregard any contribution from the mechanical seals and shaft sleeves to stiffen the shaft, and
- disregard contribution from wear or neck rings e.g. Lomakin effect.

7.14.3 Dry Mounted Centrifugal Pumps

7.14.3.1 General

Dry mounted centrifugal pumps must be:

- direct coupled to an air cooled electric motor with a flexible spacer coupling (excluding dry-mounted submersible pumps)
- have a drain tap fitted to the suction bend below the pump. The drain tap must be 25mm for pipe elbow up to a 100mm diameter and 50mm for pipe elbow 100mm or larger. The tap must be installed to direct the drain discharge in a safe direction.

7.14.3.2 Casing

Dry mounted centrifugal pump casings must:

- be fitted with replaceable sealing rings that are secured in place
- include a vent in the top of the pump casing for air release during priming, with a DN20 BSP valve for air release.

Horizontal pumps with a vertical centreline discharge are preferred, as they assist with purging of air.

7.14.4 Submersible Centrifugal Pumps

7.14.4.1 General

Submersible centrifugal pumps must:

- be able to operate partially or totally submerged in the product being pumped
- have a single pump stage
- have the impeller and motor mounted on a single shaft
- be suitable for vertical installation.

Condition monitoring for pumps >50kW must include:

- leak detection past the motor seals
- motor bearing temperature
- bearing vibration
- return condition monitoring signals to the site PLC.

7.14.4.2 Casings

Submersible pump casings must:

- have the discharge centreline aligned with the pump centreline
- have a replaceable inlet wear ring, plate or sleeve.

7.14.4.3 Impellers (sewage applications)

Submersible pump impellers, for sewage applications, must be:

- non-clogging design
- able to pass fibrous materials and solids.

7.14.4.4 Motor

Submersible pump motors must:

- be cooled:
  - by the product that the pump is immersed in, or
  - by a sealed, closed-loop cooling system, or
  - by circulating part of the pumped fluid through a cooling water jacket that is integrated with the motor housing
- be isolated from the pumped product by two mechanical seals, with an oil filled chamber between the two seals.

The motor mechanical seals must:

- be suitable for sewage and fluids containing abrasives
- have lapped seal interfaces, with depth of interface roughness less than 0.3 mm and flatness within two light bands.

The oil filled chamber between the seals must include:

- pressure compensation for the oil in the seal chamber.
- seal failure detection device to indicate oil loss from the chamber.

Seal materials must be as below.

Table 7.1 - Pump Seal Materials

Item	Lower or Product Seal	Upper or Motor Seal
	Material	
Rotating Seal Face	Tungsten Carbide or Silicon Carbide	Carbon or Tungsten Carbide
Stationary Seal	Tungsten Carbide or Silicon Carbide	Tungsten Carbide
Springs	Nickel Chrome Steel	Nickel Chrome Steel
Secondary Seal	Fluoro Carbon or Nitrile Rubber	Fluoro Carbon or Nitrile Rubber

7.14.4.5 Motor cables

Motor cables must:

- be flexible and multi-stranded. Multi-strand cable must have:
  - bell mouth cable lugs, hydraulically crimped using the correct size die (manual crimping is not permitted)

- be sized for the maximum motor current at ambient temperature 50 degrees Celsius.
- hang as vertically as possible without sagging, bellying or catenary, avoiding a low point where fat & rag can accumulate
- be installed with a cable stocking for each cable. The cable stocking must match the cable size. Multiple cables must not be supported in one stocking. Cable support stocking must be close loop weave Stainless Steel type with Stainless Steel ferrule.

Motor cables for motors with VSD must:

- be fitted with flexible, braided, screened cables. The screen must be terminated at both ends of the cable, inside the motor connection box as approved by the motor manufacturer and the connection box / LCP as per HWC direction.

7.14.4.6 **Guide Rail System**

Submersible pumps must have a guide rail system that:

- ensures correct alignment and sealing of the pump to the pump base
- is constructed of grade 316 stainless steel, including guide rails, support brackets and fasteners
- allows installation and removal of the pump from the well, without twisting or jamming of the pump whilst it is being installed and removed
- allows the complete removal of the pump without needing to dismantle the pump, adaptors or the guide rail system
- isolates vibration from the guide rails during pump operation.

Guide rail supports must have:

- a maximum spacing of 3.0m.

7.14.4.7 **Discharge Connection / Pedestal**

Submersible pumps discharge connection must:

- support the pump when operating
- provide a leak-free seal with the pump discharge
- have an installation action that wipes the seal when the pump is lowered into position, to remove any debris that could cause the connection to leak
- be capable of coupling and uncoupling by being raised and lowered through a straight vertical lift without the need to enter the wet well to install or remove the pump from the delivery piping
- have any sealing material positively fixed to the pump to facilitate replacement without the need to enter the wet well. Leakage seals must not be fixed to the pedestal.

7.14.4.8 **Lifting Bridle**

Submersible pump lifting bridle must be:

- fitted to the top of the pump
- of stainless steel grade 316
- able to support 150% of the weight of the motor and pump (to allow for the mass of wet rag, chokes)
- capable of accepting a crane hook 150 mm deep in section
- designed in such a way that when lifting either by chain or directly by crane hook, the weight distribution of the motor/pump will aid in seating and unseating of the pump from its pedestal.

7.14.4.9 Lifting Chain

Submersible pump lifting chains must:

- comply with AS 2321, made from Stainless Steel (grade 316), and tagged with compliance information
- be shackled to the pump lifting bridle to allow installation and removal of the pumps
- be a continuous length long enough to allow complete removal of the pump from the pump well or tank and at least 1m of free length above ground level and any adjacent installations such as handrail
- have a minimum working load capacity that is greater than 150% of the combined weight of the pump and motor assembly, with a minimum of 8mm diameter chain (to allow for the mass of wet rag, chokes)
- be fitted with two lifting rings for each lifting chain, lifting ring to be 150mmx100mm (minimum throat opening). Locate one lifting ring at the top of the chain and the second placed 1.5m below the top hook. When the chain is suspended by the second lifting ring the chain must hang as vertically as possible without sagging, bellying or catenary, avoiding a low point where fat & rag can accumulate
- be provided with hooks or guides at the top of the wet well to enable them to be secured so that they do not interfere with the operation, access or maintenance of the pumps or the facility

7.14.4.10 Flushing valve

Flushing valves are fitted to submersible pumps where agitation upon start up is required. The valve must:

- open automatically when the pump starts, then close automatically
- be activated by pump flow and pressure
- not require electrical components for activation.

7.14.4.11 Dry Mounted Submersible Pumps

Dry mounted submersible pumps must comply with all the requirements of ‘Submersible Centrifugal Pumps’. In addition, dry mounted submersible pumps must:

- have flanged suction and discharge ports and be bolted directly into the pipework
- be capable of operating in ambient dry conditions without overheating the motor or damaging the pump
- be mounted on a base plate or mounting pedestal
- have guide rails and lifting chains if required.

7.14.5 Positive Displacement Pump Requirements

7.14.5.1 Peristaltic Pumps

7.14.5.1.1 General

Peristaltic pumps must:

- self-prime
- pump in either direction without reverse flow (flow slipping backwards) of liquids, slurries or

suspensions
- retain liquids, slurries or suspensions within the casing in the event of a hose/tube burst within the casing
- include air vessels or pulsation dampers sized to enable smooth rate of discharge.

7.14.5.1.2 Pump Casing

Peristaltic pump casing must:
- allow removal of the rotor, hose and bearing assemblies without disturbing the inlet/outlet pipework
- have covers as follows:
  - hinged or lifting points for covers over 20kg
  - handles for covers under 20kg
- have a removable bearing housing accessible via a removable cover plate
- have connections on the rear of the casing for:
  - relieving case pressure in the event of a hose/tube burst
  - breather tubes to allow expansion/contraction of the hose lubricating fluid
  - high and low lubricant level probes
  - lubricant fill/drain points.

7.14.5.1.3 Hose/tube and connections

The peristaltic pump hose/tube must have a burst hose monitoring function.

7.14.5.1.4 Rotor

The peristaltic pump rotor must:

- be keyed to the drive shaft
- not require rotation of the shaft to ensure that it is locked in position.

7.14.5.2 Progressive Cavity Pumps

7.14.5.2.1 General

Progressive cavity pumps must:

- comprise a helical rotor which rotates within an elastomeric stator
- be self-priming
- be fitted with devices protecting them against dry running, or excessive pressure/vacuum in the suction/discharge sides respectively
- have a mechanical seal (gland packed stuffing boxes are not acceptable).
- be designed and installed such that the rotor and stator can be removed/installed without fully removing the pump from the pipework

7.14.5.2.2 Rotor

Progressive cavity pump rotors must have a bearing housing at the motor end, so that it does not rely on the motor bearing to support the pump rotor.

7.14.5.2.3 Drive assembly

Progressive cavity pumps must be fitted with flexible couplings and/or vee-belt drives to connect the motor shaft to the pump shaft.

7.14.5.3 Ram/Plunger Pumps

7.14.5.3.1 General

Ram/plunger type pumps must:

- use pulsation dampeners on the inlet/outlet when required to achieve necessary component lives or reduce pressure peaks
- have seals capable of being replaced without the removal of the plunger/connecting rod.

7.14.5.4 Diaphragm Pumps

7.14.5.4.1 General

Diaphragm pumps must:

- be self-priming
- be able to operate dry without damage

- enable diaphragm replacement without disturbing the inlet/outlet pipework.

7.14.5.4.2 Pulsation Dampeners

Diaphragm pumps should be fitted with pulsation dampeners to:

- achieve adequate diaphragm life
- reduce pressure peaks
- allow accurate flow measurement.

7.14.5.4.3 Diaphragm, Trunnion and Diaphragm Retainer Plate

Diaphragm pump diaphragms must have:

- a retainer plate
- a means of detecting diaphragm failure.

Diaphragm pump trunnion's must:

- have a means of indicating failure.

7.14.5.4.4 Crank, Bearing, Connecting Rod and Cushioning Spring

The diaphragm pump connecting rod must:

- be of variable stroke
- be spring loaded to prevent hydraulic lock and/or cushion forces acting on the diaphragm due to solids becoming trapped beneath it
- have a rolling element bearing in its drive end. This bearing must be provided with an accessible lubrication point (remote if required).

7.14.5.5 Rotary Lobe Pumps

7.14.5.5.1 General

Rotary lobe pumps must:

- have synchronised shaft rotation, to avoid contact between the rotors and/or the rotors and the casing
- allow pumping in either direction, where the application requires
- have a witness point for seal failure on the drive side of the casing. The witness point must be prior to the gear box to avoid product entering the gearbox.

Rotary lobe pump impellers must:

- be keyed to the shaft.

Rotary lobe pump shafts must be:

- high tensile steel
- sized to avoid fatigue failure.

7.14.5.5.2 Casing

Rotary lobe pump casings must:

- be able to withstand any shock loads caused by solids suspended in the pumped fluid

- have a removable front cover plate to allow rotor access
- include sacrificial inserts in the front cover plate to allow for wear
- have covers as follows:
  - for covers over 20kg, hinges or lifting points are required
  - for covers under 20kg, handles are required.

7.14.5.5.3 Rotors

Rotary lobe pump rotors must:

- have replaceable tips
- be replaceable in-situ, without pump removal
- be marked, along with the shaft, to ensure correct alignment/synchronisation upon reassembly.

7.14.5.5.4 Timing Gearbox Casing

Pump timing gearbox casing must:

- have integrally cast mounting feet with machined faces
- incorporate machined spigots and/or dowels to ensure accurate alignment with the reduction gearbox
- have seal chambers to accommodate modern mechanical seal design. Gland packing must not be used
- have bearing housings designed to prevent the ingress of dust and water.

7.14.5.5.5 Timing Gearbox Shafts

Timing gearbox shafts must:

- be of one piece construction, machined all over
- incorporate integral timing gears, enabling synchronous rotation
- be sized to withstand all loads over the specified operating range of the pump. Note that this includes Direct Online (DOL) starting
- have a first critical angular speed exceeding the maximum rotation speed seen during operation by 150%
- be able to be individually withdrawn for maintenance.

7.15 Pump Applications

7.15.1 Dosing Pumps

This section sets out requirements for dosing pumps, regardless of their application.

7.15.2 Dosing Pumps

7.15.2.1 General

Chemical dosing pumps must be:

- positive displacement
- digital speed control
- integrated flow metering
- integrated variable speed motor drive in an IP65 enclosure
- calibration by means of a calibration function integral to the pump controller
- provide a maximum capacity function (100%) for a pre-set time for priming or maintenance without changing pump settings
- dosing rate regulation by automatic adjustment of the motor speed during the discharge stroke, and by fixed suction stroke speed
- have discharge pressure factory set and be field adjustable
- constructed of materials compatible with the product being pumped
- a control panel with backlight display
- the following monitoring:
    - alarm relay output signal
    - controls include: manual, pulse, analogue, batch, cycle timer and remote on/off
    - dual level inputs
    - remote start input.

7.15.2.2 Operating Range

Dosing pumps must be:

- sized to operate within the 20%-80% band of its operating range for average daily flow
- stable operation and accuracy throughout the turndown range.

7.15.2.3 **Dosing Rate Adjustment**

Chemical dosing pumps adjustment and accuracy requirements include:

- automatically adjustable feed rates by means of adjustment of speed and stroke length
- minimum and maximum operating speeds limited to those approved by the supplier and/or manufacturer to prevent overheating, excessive wear or damage
- controls capable of providing:
    - repeatable settings within ±2% over the entire range
    - be repeatable within ±1% at a given feed rate accuracy
- supplied with standard manual Vernier, or digital indicating stroke positioner, readable to within 0.25% of full stroke
- a locking device incorporated to lock the stroke positioner to prevent accidental adjustment of the stroke.

7.15.2.4 **Protective Coating**

Dosing pumps must have an external protective coating resistant to the product being pumped.

7.15.2.5 **Pulsation Dampeners**

Pulsation dampeners' requirements include:

- be located in the discharge pipe down stream of dosing pumps and where required, in suction lines
- discharge pressure variation is a maximum of ±10%.
- a pressurised air chamber capable of being re-pressurised via a "Schrader" valve.

7.15.2.6 **Mechanically Driven Pumps**

Mechanically driven dosing pumps must:

- be gear driven by an electric induction motor
- have a variable speed drive for proportional flow control
- have oil bath lubrication with allowances for checking and maintaining oil levels.

7.15.2.7 **Electronic Dosing Pumps**

Solenoid operated dosing pumps must:

- be suitable for continuous use
- have the automatically adjustable stroke frequency with a manual override
- have the capability for manual or automatic adjustment during operation
- have a solid state pump stroke speed control that maintains a variable stroke rate proportional to flow rate
- have an adjustable speed range that is continuous between 10%-100% of maximum flow.

7.15.3 Grit Pumping

Grit pumps must be installed with a flooded suction.

7.15.4 Potable water pumps

Potable water pumps greater than 11KW must have connections on the pump flanges or casing for the connection of:

- inlet pressure gauge
- outlet pressure gauge
- venting
- drain
- seal flushing pipework
- these connections must be a minimum of 3/8 inch BSPT fitted with a stainless steel ball valve.

7.15.5 Pressure pump – package assemblies

Pressure pump assemblies are used for site pressure water. Sites with pressure pump systems must:

- identify total water flow requirements
- identify required pressure at each water use point.

Package pump stations can be used for facility water supply. Package pump stations must:

- allow for removal of any pump, keeping the remaining pumps operational (where a bank of pumps are used, allow at least one expanding component that will facilitate removal of one pump)
- have clear access to the pumps, header pipe and associated pipework
- have clearance between the pumps for lifting lugs.

During commissioning:

- test system to maximum design pressure
- measure pressure at each use point to ensure it meets the needs of the local applications.

7.16 Screenings removal machines

Screenings machines are used for removing solids from a process stream. Screenings removal installations must:

- remove solids, solidified grease and inorganic solids from sewage
- be self-clearing of screenings, with no need for operator intervention to clear screenings
- minimise grit accumulation immediately upstream of the screens by allowing grit to pass through screens
- be complete with covers and seals to prevent the escape of odours and aerosols
- include upstream and downstream penstocks for each screen
- include fall protection (channel covers, handrail or similar) for when the screen is removed. The fall protection can be temporary and only installed when the screen is removed
- include an adjacent laydown area for washdown, cleaning and maintenance.

The screen supplier must identify any service connections required, such as water or air and the required pressure, flow and quality

7.16.1 Step Screens

Step screens must:

- lift screenings to a height to allow them to be discharged into a conveyor.

Step screen machine design must:

- have interlacing bar racks. With the bar rack mounted together so that every second bar is stationary and the adjacent bars are movable
- include a park position switch that indicates that the step screen has returned to its original start position at the completion of each cycle. The park position must allow accurate parking of the moving bars, in line with the fixed step bars
- have intermediate spacers between the bars to maintain the bar spacing during operation. The spacers must be made from a replaceable bearing material and be replaced without dismantling the machine or removal from site
- have interlocked removable covers for:
    - components requiring inspection
    - components requiring servicing
    - clearing blockages
- have connection ports for foul air extraction
- allow removal without the requirement for personnel to enter the process channels
- enable the machine to be lifted from their installed position without disassembly
- allow the removal and replacement of individual bar elements of the screens without the need to dismantle the screen
- include mounting above the channel with no anchorage or fastening of the screen in the channel
- have a pivoting mount that allows the raising of the bottom of the screen from the channel
- have lifting lugs for removal
- include electric motor drives. Drive mechanism to be mounted above the channel
- include an electronic sheer pin to protect the machine from over torque
- have individual grease lines to moving parts, plumbed from the top of the machine
- take account of wearing effects of grit
- minimise use of submerged rotating parts.

Plant design considerations; the step screen must:

- have less than 3mm from the channel to the bottom of the screen face
- have 50mm clearance on each side of the screen to the channel wall
- have channel covers sized to allow for the swing of machine.

Note: step screens operate optimally with constant differential head across the screen.

Installation considerations; step screens must be installed:

- with side covers to be split at the top of channel.

7.16.2 Band Screens

Band screen design must:

- include perforated plate for screenings capture from the effluent
- be able to transfer screenings to a conveyor (sluice or screw conveyor), without operator assistance. Belt conveyors are not suitable to be coupled with band screens
- have any spray bars removable from the band screen for cleaning of nozzles
- have no rotating components below channel
- have maintenance access to the rotating components
- allow removal and replacement of screen panels from the top of channel, without dismantling the machine or removing the entire screen from channel
- include seals that eliminate the potential for screenings bypassing the perforated plate
- include overload and damage protection which stops the machine before it damages itself
- allow removal from channel without any disassembly.

Band screens must be sized:

- to have effluent velocity less than 1.1m/s entering the screen at 60% blinding.

7.16.3 Drum Screens

The drum screen must capture screenings on a cylindrical screen element and continuously discharge screens from the drum. Drum screens must:

- be internally fed
- have a controlled overflow mechanism
- have splash guards to contain and direct the entire flow through the drum and exiting the screen without any splashing onto surrounding surfaces or equipment
    - splash guards must be removable for maintenance or inspection purposes
- have any sprays accessible for cleaning and maintenance.

7.16.4 Manually raked bar screens and trash racks

Manually raked bar screens and trash racks can be used on waste water treatment plant bypass streams. Manually raked screens must:

- have maximum length of bar face 1200mm
- be inclined greater than 30deg to vertical
- provide a clear, unobstructed surface on the front of the comprising only the edges of the vertical bar elements
- allow an operator to use a rake to pull screenings up the bar elements for removal, without fouling on screen supports
- be supplied with a rake for use with the manual bypass screen. The rake:
    - tines must match the spacing of the bar elements
    - handle must be sized (length) to allow an operator (approximately 1.7m tall) to reach the bottom of the screen without bending over from the access platform
- provide personnel access to the screen for manual screenings removal after operation of the screen, when no flow through the screen. The screen must be isolatable for safety of personnel when flow is passing through the screen

- provide an integrated perforated metal drain pan onto which screenings can be raked. The drain pan must be capable of supporting the weight of the wet screenings and two operators.

Plant design must allow clear access to a screenings dewatering machine, screenings conveyance or a waste bin to dispose of manually raked screenings.

7.17 Screenings Washing Machines

Screening washing machine wash screenings removed from screening machines. The screening washing machine must:

- be able to receive screenings from a screw conveyor or sluice
- discharge screenings to a bin. The bin will be taken offsite by vehicle for screenings disposal
- have the agitation impeller directly coupled to the drive motor and sealed on the rotating shaft
- have an impeller designed for the liquefaction of the faecal solid within its tank
- include a compactor screw fitted with hardwearing nylon brushes on the periphery of the screw blades. The brush must be fastened to the screw blades to allow adjustment of the brushes onto the compactor, when wear occurs
- all areas of the screw compactor (including top) and impeller must be available for viewing and servicing via hinged covers with support to hold the cover open. The covers are to be electrically interlocked to prevent machine operation when opened
- include rodding point on the drainage pipework from the wash/press for inspection and to remove blockages
- use site reclaimed water (where available)
- include a screenings system with an aperture of 5 mm in the drain system or on the discharge to capture coarse stones to prevent their discharge to the site drainage system. This screening system must be lightweight and removable.

7.18 Sludge Thickener and Sludge Dewatering Machines

This clause relates to machines for thickening sludge and dewatering sludge, prior to disposal. The commissioning of sludge thickeners and sludge watering machines will include monitoring of:

- bowl speed (RPM)
- centrifugal force (g)
- inlet pool depth (mm)
- differential speed between bowl and scroll (rpm)
- scroll torqued (kNM), in the case of variable speed scroll
- sludge fee rate (m3/hr)
- solids loading (kg/hr)
- feed solids concentration in thickened sludge (%)
- polymer used (kg/dry ton)
- centrate solids concentrate (NFR mg/L)
- solids capture rate (%).

Sludge thickener and sludge watering machine commissioning must include:

- validate moisture content for each machine, taking samples every 2hrs over an 8 hour period.

7.18.1 Centrifuges

Centrifuges must:

- be able to operate continuously without operator intervention
- respond to changes in sludge flow rate and characteristics
- include material selection rated for the abrasiveness of the sludge, with abraded components designed for 5 years of continuous operation
- include the following monitoring functions
  - detection of excess vibration
  - over torque of bowl and scroll
  - measurement of bowl and scroll speed
- have the bowl and scroll statically and dynamically balance before and after assembly, with results included in Inspection Test Plans
- include adjustable weir plates.

Centrifuge installation must:

- include mounting that isolates vibration generated by the centrifuge
- have flexible connections to any connecting chutes or pipes, to isolate vibration
- be installed with an access platform that enables access to wearing and maintainable components.

7.19 Strainers (automatic backwashing)

This section applies to automatic backwashing strainers for treated effluent re-use systems. Automatic backwashing strainers must:

- strain to one third of the largest downstream aperture
- have a cleaning cycle that clears solids and fats
- be based on a screening process, media type strainers are not acceptable
- be designed for continuous removal of particles
- maintain a clean pressure drop of less than 50kpa
- have an automatic air release valve fitted at the highest point of the strainer
- include a drain valve at the lowest point
- have automatic backwashing triggered by a pre-set differential pressure across the screen
- have backwashing occur while the strainers is “online”
- have all internal parts made of stainless steel
- have strainer body inspectable and removable through an access hatch
- have 2 straining stages, a course screen, followed by a fine screen.

7.20 Surface Aerators

Surface aerator impellers must be:

- fabricated from steel
- coated with high build marine epoxy
- of an open blade type or inverted cone that rag cannot collect on;
- dynamically balanced.

Surface aerators mounted on floating pontoons must:

- include deflectors which eliminate spray and aerosol above the aerator platform
- have maintenance and access platforms around all maintainable items, including the motor and gearbox
- be capable of supporting the weight of the aerator when the tank or lagoon is drained. The pontoon can have a maximum bearing pressure of 500kPa on the tank or lagoon floor
- have a structural resonant frequency above 7Hz and to exceed any forcing frequency by a minimum of 20% (e.g. the impeller blade passing frequency)
- be vertically liftable for removal by a mobile crane, without the need to dismantle associated installations
- have access walkways that include pivot points, which have grease nipple and can be inspected for wear. Access walkways designed must take into account dynamic loads and constant movement of the water surface.

7.21 Ultraviolet Disinfection systems (mechanical)

UV systems are used to disinfect water using ultraviolet light. UV systems involve principally process elements with electrical drive and control, mechanical elements to consider include:

- accumulation of solids and algal weed on the equipment
- access to lamps and equipment for maintenance
- lifting requirements
- isolation
- UV system bypass
- wash down area
- layout and equipment housing.

The UV banks must:

- be freestanding when removed for maintenance, or
- be provided with stands or cradle for 2 banks for supporting the banks during maintenance
- contain 10% redundancy of lamps within each bank, to allow for lamp failures
- have a minimum lamp bank redundancy of n + 1, to allow 1 bank to be removed for cleaning.

7.21.1 Algal weed and solids

Algal weed and solids must be considered in designs with capture prior to the UV system. Screening prior to the UV system must comply with the requirements of the UV equipment supplier.

Solids and algal weed will impact the effectiveness of the UV system by:

- reducing the effectiveness of the UV disinfection
- increasing electricity usage
- accumulating on baffle plates and other flow manipulators resulting in increased cleaning frequency.

7.21.2 Access to lamps and equipment

Lamps will fail and need replacement, during design consider safe access:

- to the UV lamp banks in their installed position for removal
- to ancillary equipment (including level transmitters, flow transmitters, transmissivity meters, etc)

- around the channel when the UV banks are removed from channel
- that avoids the need for man access to the channel.

7.21.3 Lifting UV system components

Lifting equipment in a UV system must consider:

- lifting the lamp banks clear of the channel (vertical lift)
- placement of the lamp banks for cleaning and maintenance on the wash down area (horizontal range)
- lifting baffle plates or other equipment in the flow, which will accumulate solids and require cleaning
- the total weight of the wet lamp, with accumulated screenings and algae.

If lifting equipment is fitted, the components of the lifting equipment must be contained and not contact the lamps, specifically chain blocks must be fitted with chain buckets.

7.21.4 Isolation

UV lamp banks must be physically and electrically isolatable for maintenance.

7.21.5 UV system bypass

The UV system must include a flow bypass of the UV system. The UV system may need to be bypassed due to power failure or maintenance.

7.21.6 UV lamp wash down area

A wash down area must be provided for washing the UV lamp banks and performing maintenance. The wash down area must:

- allow for capture and disposal of wash down water, solids and algae. The wash down pad will include:
  - bunding, to contain wash down water
  - with 3 bund walls to be equal in height to the top of the UV bank on the stand, to capture wash down overspray
  - a collection sump with strainer basket to collect solids
  - a drain or pump to return wash down water to the site foul water system, bioreactor or inlet works
- consider manual handling and work height for lamp cleaning
- be chemical resistant to cleaning chemicals (including nitric acid)
- have supply of wash down water (potable or re-cycled water) adjacent to the bund.

7.21.7 Layout and equipment housing

The UV system layout must include:

- housing of UV electrical equipment (including ballast cards) in an air conditioned room
- truck/crane access for equipment lifting (where permanent lifting is not provided)
- positioning of automatic samplers and allowance for services to and from the auto sampler. Auto samplers inputs and outputs are typically power supply, sample line and waste lines

- weather protection over the UV lamps and lamp wash down area to allow lamp cleaning in all weather conditions. Where lamps are not required to be cleaned in all weather conditions weather protection is not required
- area lighting
- position of bollards to protect equipment and structures. Bollards can be positioned post construction when risk assessment can be performed.

Note: where site re-use water is extracted after the UV system, the off take should be after the UV lamps, but prior to any downstream weirs to ensure continuity during low diurnal flows.

7.21.8 Flow Manipulation

Removable partial channel blockouts may be used to narrow the UV channel. Partial channel blockouts narrow the channel at the UV lamps and can be removed to allow installation of additional UV banks and increased flow in future upgrades.

7.22 Valves

7.22.1 Valves – General Requirements

Valve selection must take into account the operating conditions of the application, including:

- pressure
- temperature
- fluid properties
- operation: automatic or manual

Valves must:

- have a design life of at least 25 years
- be of pressure class PN16 or greater
- close in the clockwise direction when looking from the top of the valve

Manual valves must be located and orientated:

- for ergonomic operation
- 1.8m or less above floors or access platforms for valves of bore 100mm diameter or less
- 1.2m or less above floors or access platforms for valves of bore 100mm diameter or more
- to avoid the need for temporary access equipment for operation e.g. ladders

Actuated valves must:

- have fittings for manual operation
- be supplied as a complete and operating assembly with actuators, positioners, pilot valves, solenoid valves, internal piping, prefilters, regulators, torque limiters, silencers, speed controllers needed for reliable and effective operation.

Do not use DN65 or DN125 mm valves, except for DN65 landing valves used in fire services.

7.22.2 Valves for Energy Isolation

Valves used for isolation of energy sources must be knife gate or globe type valves. Butterfly valves must not be used for isolation.

7.22.3 Valve Operating Environment

The valve must be able to operate in:

- temperature range -5 to 50 degrees Celsius

7.22.4 Valve Design

Valves must be designed:

- with flanges complying with AS 4087
- to open against full unbalanced head and closing against full flow
- to open and close smoothly without damage due to vibration or cavitation
- for maximum operator effort of 150N at the hand wheel or lever or geared actuator under the worst conditions of differential head or unseating force
- to have self draining valve body, where water or moisture can pond or accumulate on the valve body or associated equipment
- to be drip tight in the closed position. Where leakage occurs, the leakage rate must not exceed that specified in the relevant Australian Standard or project specification
- to have lifting attachments, for valves weighing more than 20 kg

Valve installations must be designed:.

- with access for operation (including exercising), maintenance and valve removal without obstruction by other equipment, working over water or working at heights
- with the valve spindle or actuator vertical, above the valve body
- with isolation valves upstream and downstream of control valves and automated valves to allow the removal of the valves for service and repair. The downstream valve is not required if downstream connections can be isolated
- with supports for the valve, to eliminate stresses on the valve from connecting pipework and fittings
- with dismantling fittings to allow valve removal without the need to remove adjacent pipe and fittings
- with unions on both sides of a valve, for 50 mm nominal bore and smaller valves.

7.22.5 Valve Materials

Valves must meet the following materials requirements:

- castings free of defects, such as holes or porosity or insufficient thickness. Holes or blemishes must not be filled
- no welding of cast iron or ductile iron components
- have protective coatings to achieve the design life requirements.

7.22.6 Valve Testing

Valves DN 200 and larger must be hydrostatically tested in accordance with the relevant Australian Standard or other valve design standard.

7.22.7 Actuated Valve Limit Switches

Actuated valves must be fitted with limit switches to indicate when the valve is in the open and closed positions. For electric actuators provide switches that are an integral part of the actuator.

Limit switches must comply with STS500.

7.22.8 Valve Identification and Marking

Valves 100mm and larger diameter must be labelled with the following information:

- manufacturer's brand
- valve size and type
- year of manufacture
- pressure rating in kPa
- P&ID tag number
- valve purpose or function
- direction of fluid flow
- its weight, where the valve weighs more than 20kg

Valve handwheels must labelled with the words “OPEN” and “CLOSE” with arrows adjacent to indicate the direction of rotation.

7.22.9 Specific Valve Applications

7.22.9.1 Aeration (blown air) System Valves

Aeration system isolation valves must be butterfly or eccentric plug valves.

7.22.9.2 Aeration system flow control applications must be butterfly valves.Sludge and Scum

Valves used for scum and sludge applications must be gate valves.

Valves use for digested sludge, thickened/dewatered sludge or scum must be gate, diaphragm or pinch valves.

7.22.9.3 Industrial and Recycled Water Services

Industrial or recycled water services on HWC sites, must use:

- ball valves or globe valves up to and including DN50 mm for isolation
- gate valves for larger than DN50 mm for isolation.

7.22.9.4 Potable Water Services

Potable water service must:

- have a dampening device to prevent water hammer with solenoid valves
- not use butterfly valves.

7.22.9.5 Biogas

Valves used on biogas systems must

- meet regulatory requirements
- use dual seat fire safe butterfly valves for isolation for DN80 and larger
- use ball valves for less than DN80.

7.22.9.6 Odour Control

Odour control foul air extraction systems can use butterfly dampers for isolation.

7.22.10 Ball Valves (DN 50 or less)

Ball valves must:

- have a bore of 100% of the internal pipe diameter
- be made of stainless steel for water and air systems

7.22.11 Butterfly Valves

Butterfly valves must not be used for isolation or on chemical dosing systems. Butterfly valves must only be installed when approved by HWC.

Butterfly valves must:

- comply with AS 4795
- be used for flow throttling applications
- have a bore of 100% of the internal pipe diameter
- be used for fluids containing minimal solids and debris, especially hair and fibre
- be lugged or flanged, to allow adjacent pipework to be removed without disturbing the valve
- have the sealing disc positively fixed to the shaft by a spline, square section or similar section or have the disc shaft integral with the disc, to prevent disc from rotating on the shaft. The disc must not be fastened to the shaft by bolts, pins or fastenings
- have valve seats that are drip tight in both directions at the pressure differentials applicable
- be orientated with the spindle vertical. Where process fluid may contain sediment or grit, position the valve with the spindle horizontally
- have positive mechanical stops in both open and close positions, when actuated
- have, for lever operated butterfly valves:
    - position setting plates with ten notches or
    - lockable setting with infinite position setting plates, where used for throttling applications.

Buried and submerged butterfly valves must have a remove position indicator visible from ground.

7.22.12 Diaphragm Valves

Diaphragm valves must:

- be straight through type diaphragm valves. Weir type diaphragm valves are only acceptable where there are no solids in the piped product
- have a rising position indicator to indicate valve plunger position.

Diaphragm valves with pneumatic actuation must:

- be spring to close, air to open
- be capable of operating with the maximum valve design line pressure and the minimum supply air pressure
- have a manual override
- have a visual position indicator.

7.22.13 Gate Valves

Gate valves must:

- be manufactured in accordance with AS 1628-1999: Water supply.

Metal seated gate valves must:

- comply with AS2638.1
- be made from materials listed in columns 2, 3 and 4 of AS2638 Table 2.1.

Resilient seated gate valves must:

- comply with AS 2638.2
- have enclosed bonneted non rising spindle valves, with bonnets rated for the full rated pressure of the valve
- Provide extension spindles and spindle supports when valve is to be operated remotely from platforms etc.

7.22.14 Knife Gate Valves

Knife gate valves must:

- comply with AS 6401 and WSA PS – 266
- be knife edge gate valves of self-cleaning design, with a bore of 100% of the pipe area.
- have rising spindle valves, with a full depth square thread spindle made of stainless steel, do not use grade 303 stainless steel for this application
- have gate self aligning packed gland
- a self-lubricating hand wheel nut
- no protrusions projecting into the flow
- a resilient seat material
- a self-cleaning design, able to cut through and dislodge material that may be caught between the gate and the seat during closing
- have a fully lugged or flanged bodies, to allow the valve to remain in place when the pipework on one side of the valve is removed

- be drip tight in the closed position.
- indicate the required flow direction on the valve body, if the valve is design for flow in only one direction.

Use knife gate valves to isolate the flow of sludge, scum or streams containing solids.

Do not use knife gate valves for:

- tank isolation
- buried or submerged service.

7.22.15 Globe Valves

Globe valves must:

- have replaceable discs
- have replaceable or repairable seats, for valves larger than DN100
- be used on clean fluids
- be used for drip tight isolation and throttling applications
- be made of bronze, up to and including DN80
- be made of cast or ductile iron above DN80.

7.22.16 Plug Valves

Plug valves must:

- plug valves must be flanged type (PN16 to AS 4087)
- plug valve bores must be 100% of the pipe area to which the valve is fitted
- valve bodies and plugs must be of SG iron construction
- provide lever operated manual plug valves with ten (10) notch position setting plates
- use lubricated taper plug valves to control the flow of process water or recycled effluent
- the force required on the end of the lever to operate the valve between fully open and fully closed position must not exceed 180N
- where lever operator force would exceed 180 N, provide a geared operator.

7.22.17 Pressure sensitive Valves

7.22.18 Pressure Reducing Valves

For valves less than or equal to DN50:

- pressure reducing valves for clean water and air must be direct acting and have bronze bodies, neoprene diaphragms and discs
- pressure reducing valves for chemical dosing pumps must made of plastic.

For valves larger than DN50:

- pressure reducing valves for clean water and air must be pilot operated with ductile iron, reinforced synthetic rubber diaphragms and discs
- unless specified otherwise, the outlet pressure adjustment range of pressure reducing valves must be 170 to 550 kPa.

7.22.19 Pressure Sustaining and Back Pressure Valves

Pressure sustaining and back pressure valves must maintain a constant upstream pressure.

7.22.20 Pressure Relief Valves

Pressure relief valves protect equipment from over pressure. Pressure relief valves must be:

- direct acting spring loaded type
- adjustable, with the adjuster protected against unauthorised tampering by suitable cover and seal
- sized and set to relieve the maximum flow of liquid or gas without exceeding the design pressure of the equipment
- fitted with a lifting lever to allow valve to be operated by hand, for compressed air applications
- pre-set to the pressure required relief pressure before delivery to site. The set pressure must be stamped onto an aluminium tag and attached to the valve by a stainless steel wire.

Plastic relief valves must have union end connections.

7.22.21 Reflux Valves (Check or Non Return)

Reflux valves must:

- be installed horizontal (not in vertical pipe)
- be installed a minimum of 5 pipe diameters downstream from pump discharges and pipe fittings that cause flow disturbance and at least 2 pipe diameters upstream from pipe fittings that cause flow disturbance
- have an external position indicator. The position indicator may require guarding depending upon the specific installation and indicator type
- be swing check type for valves DN 100 mm and greater
- self-lubricating sleeve type trunnion bearings
- have inspection covers, where trunnion bearings are fitted
- be ball type check valves where it is necessary to mount check valves vertically or for flow that include solids (E.g. sludge)
- be spring loaded ball type with stainless steel, for plastic pipework DN 50 mm or smaller.
- valves DN150 and greater provide a tapping point on downstream side with ball valve to allow air bleed off, pressure release, drain and or test point.

7.22.22 Solenoid Valves

Solenoid valves must:

- be suitable for use with clean water (industrial water) and water containing contaminants (recycled effluent)
- have manual override
- be 24 volt dc
- be minimum IP65 rated
- have an led in plug to indicate it has power supply
- be designed to allow coil replacement without shutting off water supply through the valve
- be one of the standard sizes, 20mm, 25mm, 40mm or 50mm

- have bore equal to or greater than the nominal bore of the pipe
- be installed with barrel union each side of the solenoid for disassembly
- have stainless steel valve body when installed in coastal environments or at inlet works without odour capture. Brass is acceptable for other applications.

7.22.23 Low Pressure and Vacuum Relief Valves

Low pressure and vacuum relief valves must be designed to protect low pressure gas storage and handling systems from over pressure or collapse from a vacuum. Low pressure and vacuum relief valves must:

- discharge directly to atmosphere
- have the set pressure and vacuum adjustable by the addition or removal of weights
- be capable of passing the full rated flow at 100% over pressure, i.e. at twice the set pressure
- be suitable for pressure up to 15 kPa
- be oversized to minimise pressure losses across the valve
- have replaceable seat rings
- be guarded at pressure and vacuum ports.

8 Related Documents

In addition to STS 600, all work must comply with relevant current Standards and regulations inclusive of all amendments. In particular:

- Workplace Health and Safety Regulations
- WorkCover NSW Codes of Practice
- Safe Work Australia Model Codes of Practice
- Hunter Water's Design Manuals
- Hunter Water's Standard Technical Specifications
- Hunter Water's Standard Drawings

Appendix A: Standards is a list of Standards referenced in this specification and other Standards relevant to the scope.

9 Document Control

Document Owner: Group Manager Planning & Engineering

Document Approver: Executive Manager Customer Delivery

Version	Author	Details of change	Approval Date	Approved by	Next Scheduled Review
1.0	G Baker	Initial Release	Dec 2013	S Horvath	Dec 2015
2.0	G Baker	Insertion of STS references	Feb 19	L Backhausen	Feb 19
3.0	R. Watson	Complete Review	28/07/2020	G.Robinson	July 2022
4	G.Moore	Pump and valve content added, minor additions.	8/07/2022	R.Main	As per Corporate Standard HW2013-421/22.002

Appendix A: Standards

For clarity, where a Standard has several Parts and/or Amendments and/or Supplements, the Reference Number is for the leading Part of the Standard band the Title notes what additional elements are included.

Reference Number	Title
AS/NZS ISO 9001:2008	Quality Management Systems – Requirements
General Australian Standards	
AS1111	ISO metric hexagon bolts and screws
AS1112	ISO metric hexagon nuts
AS1269	Occupational noise management
AS1418	Cranes, hoists and winches
AS1657	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS1755	Conveyors – Safety Requirements
AS2129	Flanges for pipes, valves and fittings
AS2550.1	Cranes, hoists and winches.
AS2550.3	Cranes, Hoists & Winches - Safe Use Part 3: Bridge, Gantry, Portal Cranes
AS2729	Rolling bearings - Dynamic load ratings and rating life
AS2784	Endless wedge belt and V-belt drives
AS2938	Gears - Spur and helical - Guide to specification and rating
AS4024	Safety of machinery
AS4087	Metallic flanges for waterworks purposes
AS4254	Ductwork for air-handling systems in buildings
Metalwork Australian Standards	
AS 1101	Graphical symbols for general engineering – Set
AS 1163	Cold-formed structural steel hollow sections
AS 1167	Welding and Brazing – Filler Metals
AS 1170	SAA loading code (Minimum design loads on structures)
AS 1171	Non-destructive testing – Magnetic particle
AS 1214	Hot-dip galvanised coatings on threaded fasteners
AS 1237	Plain washers for metric bolts, screws and nuts for general purposes
AS 1275	Metric screw thread for fasteners
AS1345	Identification of the contents of pipes, conduits and ducts
AS 1442	Carbon Steels and Carbon Manganese Steels - Hot rolled bars and semi finished products
AS 1444	Wrought alloy steels - Standard and hardenability (H) series

Reference Number	Title
AS 1448	Carbon Steels and Carbon Manganese Steels - Forgings
AS 1450	Steel tubes for mechanical purposes
AS 1554	Structural Steel Welding Set
AS 1594	Hot-rolled steel flat products
AS 1595	Cold-rolled, unalloyed, steel sheet and strip
AS 1627	Metal Finishing - Preparation and pretreatment of surfaces
AS 1664	Aluminium Structures
AS 1665	Welding of Aluminium Structures
AS 1665	Welding of aluminium structures
AS 1674	Safety in Welding and allied Processes
AS 1710	Non-destructive testing – ultrasonic
AS 1796	Certification of welders and welding supervisors
AS 1830	Grey cast iron
AS 1858	Electrodes and fluxes for submerged-arc welding
AS 1874	Aluminium and aluminium alloys – Ingots and castings
AS 1929	Non-destructive testing – Glossary of terms
AS 2062	Non-destructive testing – Penetrant testing
AS 2074	Cast steels
AS 2084	Non-destructive testing – Eddy current testing
AS 2177	Non-destructive testing – Radiography
AS 2205	Methods for destructive testing of welds in metal - set
AS 2207	Non-destructive testing – Ultrasonic testing of fusion-welded joints
AS 2214	Certification of Welding Supervisors - Structural Steel Welding
AS 2717	Welding - Electrodes - Gas metal arc
AS 2812	Welding, brazing and cutting of metals – Glossary of terms
AS 2980	Qualification of welders for fusion welding of steels
AS 3009	Electrical Installations – Emergency power supplies in hospitals
AS 3545	Welding positions
AS 3678	Structural steel - Hot rolled plates, floorplates and slabs
AS 3679	Structural steels, Parts 1 and 2
AS 3978	Non-destructive testing – Visual inspection
AS 3990	Mechanical equipment - steelwork
AS 3998	Non-destructive testing – Qualification and certification of personnel
AS 4041	Pressure piping

Reference Number	Title
AS 4087	Metallic flanges for waterworks purposes
AS 4100	Steel structures
AS 4594	Internal Combustion Engines
AS 4600	Cold formed steel structures
AS 4671	Steel reinforcing materials
AS 4792	Hot dipped galvinised coatings on ferrous hollow sections
AS 4882	Shielding gases for welding
AS/NZS 1111	ISO metric hexagon bolts and screws - Product grade C, Part 1 - Bolts
AS/NZS 1112	ISO metric hexagon nuts - Product grade C – Part 3
AS/NZS 1252	High-strength steel bolts with associated nuts and washers for structural engineering
AS/NZS 1664	Aluminium structures, Part 1 & 2
AS/NZS 1734	Aluminium and aluminium alloys - Flat sheet, coiled sheet and plate
AS/NZS 1865	Aluminium and aluminium alloys – Drawn wire, rod, bar and strip
AS/NZS 1866	Aluminium and aluminium alloys – Extruded rod, bar and hollow
AS/NZS 1867	Aluminium and aluminium alloys – Drawn tubes
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS ISO 3834	Quality requirements for fusion welding of metallic materials - Set
International Standards	
ANSI 16.5	Pipe Flanges and Flanged Fittings
ISO 20816-1	Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts General guidelines
Valve Standards	
AS 1271	Safety Valves, other valves, liquid level gauges and other fittings for boilers and unfired pressure vessels
AS 1565	Copper and copper alloys – Ingots and castings
AS 1628	Water Supply – Metallic gate, globe and non return valves
AS 1831	Ductile Cast Iron
AS 1939	Degrees of protection provided by enclosures for electrical equipment
AS 2129	Flanges for Pipes, Valves and Fittings
AS 2345	Dezincification resistance of copper alloys
AS 2638.1	Gate valves for waterworks purposes – metal seated
AS 2638.2	Gate valves for waterworks purposes – resilient seated
AS 2837	Wrought alloy steels – Stainless steel bars and semi-finished products
AS 3952	Water supply - spring hydrant valve for waterworks purposes

Reference Number	Title
AS/NZS4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS 4794	Non return valves for waterworks purposes – Swing check and tilting disc
AS 4795	Butterfly valves for waterworks purposes
AS 5081	Hydraulically operated automatic control valves for waterworks purposes
AS 6401	Knife gate valve for waterworks purposes
WSA 106	WSAA Industry standard for kinetic air valves
ISO 8573.1	Compressed Air – Part 1: Contaminants and Purity Classes
ISO 5210	Industrial Valve – Multi Turn Actuator Attachment
ISO 5211	Industrial Valve – Part Turn Actuator Attachment
IS EN ISO 13397	Industrial Valves: Diaphragm valves Made of Metallic Materials
IS EN ISO 16138	Industrial Valves: Diaphragm valves Made of Thermoplastic Materials