

General Mechanical Works

TMS1639

Standard Technical Specification

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# Scope

This specification is intended to provide details and instructions on the minimum requirements for design, manufacture, installation, testing and commissioning of a mechanical installation on a facility that is intended to be owned, maintained and operated by Queensland Urban Utilities. This specification may also be used for projects that include upgrading, overhaul or repair of existing QUU facility assets.

The overall requirement is for new and upgraded mechanical facilities at QUU to be designed and installed so as to be as reliable, efficient, serviceable and safe as is practicable.

# General Requirements For all Mechanical Installations

Specific constraints, limitations, capacities and performance requirements for machinery installations shall typically, either be stated in the Project Requirement Document, or shall be able to be determined by the facility designer from information provided in the Project Requirements Document. Nevertheless, unless specifically stated otherwise in the Project Requirements Document, the Contractor’s Design Engineer is required to check and confirm all design criteria and sizing information for mechanical equipment. The values and the source of design criteria information must be provided in the relevant design report, as per SDRL.

## Operating Conditions and Design Life

Unless specified otherwise, in the Project Requirements Document, equipment shall be designed for minimum design life duration as stated below for the intended environment and duty. The equipment shall also be suitable for normal continuous operation with only minimal routine maintenance as specified by the component manufacturer.

|  |  |
| --- | --- |
| Component | Minimum Design Life |
| Stainless Steel Process Tanks | 30 years |
| FRP/GRP/PE/PVC Process Tanks | 25 years |
| FRP/GRP/PE/PVC Process Pipe | 25 years |
| Process Fluid Pumps | 25 years |
| Process Fluid Mixers | 20 years |
| Chemical Dosing Pumps | 10 years |
| Instrument Air Compressors | 15 years |
| Aeration Blower | 30 years |
| Penstocks/stop boards | 50 years |
| Penstock Lift Mechanisms | 25 years |
| Serially Manufactured Valves | 25 years |

## Service Requirement

Mechanical equipment and process facilities shall be designed, selected and installed on the basis that they will generally need to provide continued service for long periods, without frequent maintenance and attention being necessary to continue operating in accordance with the design intent.

## Commonality of Equipment and Parts

The designers shall use common/interchangeable equipment within a process facility with the same function and capacity requirement as much as is practicable to reduce the number of spares that will be needed and to make machinery items interchangeable wherever possible.

## Ability to Carry Out Routine Servicing With the Machine in Place

Parts that are subject to wear shall be readily accessible and simple to replace with the machine in place.

Designs shall also provide for safe and easy access for inspection and other routine servicing. All lubrication points shall be arranged so as to be readily accessible, and where necessary, suitable access platforms, extension pipes etc. shall be fitted.

Removable inspection panels or sensor covers shall not be obstructed by pipe, handrail or support structure items.

## Availability of Spare Parts

Replaceable parts and consumables on equipment items shall be readily available in Brisbane, Queensland. Where parts are not held in Brisbane the supplier must provide information on where stocks of parts are held and confirm that parts are able to be dispatched so that they will be available in Brisbane within three working days.

A list of essential spares, and their cost, sufficient for two (2) years routine maintenance under normal operating conditions shall be provided by the Mechanical Equipment Contractor.

Details on essential spare parts shall be provided in the equipment data sheets.

## Critical Spares

The Mechanical Equipment Contractor (the Contractor) shall provide a Provisional Item for the supply of a single set of all critical spares (either spare parts or fully assembled machines), based on the Design Engineer’s assessment of at least the following criteria, for each installed item of equipment:

1. The maximum time that a particular process element can be allowed to be unavailable;
2. The individual required plant item availability within the process element that it serves;
3. The reasonably foreseeable worst-case delivery time for replacement parts; and
4. The reasonably foreseeable worst-case time required to strip and repair/reassemble the particular plant item and return the plant item to service.

The Contractor’s Design Engineer shall provide the above parameters, costs and analysis and shall be included in the design report. The recommendations to hold critical spares shall be included in the Asset Risk Register. The final set of critical spares shall be subject to acceptance by the Principal.

Note that the Contractor may be required to supply more than one unit of certain spares that are assessed as being critical. Any spare parts to be provided as part of the Project shall be packed and protected for storage to AS2400. Electrical equipment shall be sealed in plastic or similar bags with a liberal supply of desiccant. Other items shall be protected so as to avoid corrosion and spoilage for an indefinite period unless there is a specific explanation provided for the limited shelf life of the item. The Contractor shall provide clear and detailed instructions where specific storage requirements are required. As a default, assume that spares will be stored on site in the equivalent of a shipping container placed on ground without ventilation.

## Special Tools

The Equipment supplier and the Contractor’s Design Engineer are required to make themselves aware of the required set of tools that will be necessary to maintain, strip and reassemble and set up the proposed machine equipment, and make particular note of any special tools that will be required. Special tools are defined as tools that cannot be procured “over the counter” at the local industrial tools store. QUU’s preference is for machinery that does not require any special or propriety tools, so the need for special tools shall be minimised to cases where no other alternative is practical. Where special tools are required, a complete set of special tools must be supplied to the Principal, unused as part of handover and commissioning works.

## Nameplates

A nameplate manufactured from stainless steel grade 316 shall be affixed to the body of the all motor driven machines/plant items by means of stainless steel grade 316 screws, stamped or engraved with such relevant machine and performance attributes as per the following, non-exhaustive list:

1. Manufacturer’s name;
2. Model/type descriptor;
3. Serial number;
4. Rated thrust;
5. Rated speed;
6. Maximum speed;
7. Propeller pitch (fitted);
8. Motor rating (air);
9. Motor rating (water);
10. Total weight; and
11. Date of manufacture.

Submersible pumps must be provided with a second identical nameplate installed in the switchboard.

## Materials

The Contractor shall take care and provide evidence that materials for mechanical equipment components have been selected appropriate to service conditions, loadings, duty, stresses, application and cycles to achieve the required service life of the mechanical equipment, free from corrosion, cracking and various types of wear or material failure.

All steelwork subject to immersion, splash or spray shall be stainless steel Grade 316 as a minimum;

All new metal walkways and all handrails (including gates) shall be marine grade aluminium; and

All bolts, nuts and non-insulating washers shall be Grade 316 stainless steel.

Certificates shall be provided with all materials to demonstrate that the material meets the appropriate Australian Standard. If material is to an international standard then the certification requirements shall be agreed in writing with the Principal, otherwise the material and/or equipment shall not be accepted. The Principal will generally acknowledge common British, Western European and North American standards as being acceptable, however, other standards may not be considered to be acceptable. The Principal’s decision on acceptable international standards is binding.

Further details on materials of construction are provided in the equipment specific specifications or in the Project Requirements Specification.

In all cases, bolts and machine screws shall have appropriate markings or certificates supplied to clearly indicate grade of material.

The Contractor must take precautions to prevent degradation or damage of materials and equipment from occurring, prior to and, during construction, as well as, up until commissioning and handover. Painted parts must be handled and stored to prevent scratching, chipping or contamination of protective coatings. Such precautions may include, but may not be limited the use of protective and padded supports to prevent parts from contacting the ground or each other. Elastomer and polymer products must be protected from damage that may be caused by exposure to UV, dust, humidity biological agents and other airborne contaminants. Such precautions may include, but may not be limited to storage within a building or temporary shelter and if necessary, maintenance and resealing, of protective packaging.

For critical machine parts, the Contractor must ensure that materials are traceable via a suitable quality system. The Principal may reject materials if the materials in question cannot be traced back to a source or be shown to comply with a suitable quality system.

## Dissimilar Metals

Where it is necessary to connect dissimilar metals, for example Aluminium hand rail to Steel structures, the parts shall be separated using phenolic sleeved washers and packers. Refer to Section 2.17 Bolts and Fastenings Protective coatings applied to plain carbon steel structures shall not be considered as suitable separating material in this regard.

## Design of Access to Mechanical Installations

Wherever possible, equipment shall be located to provide safe, convenient and unobstructed access for maintenance with the machine in place, as well as future removal and replacement. The machinery installation design must consider how future maintenance, removal and replacement activities can be carried out while adjacent and associated plant are able to continue to operate if necessary. The mechanical facility designer must consider and make provision for

At least 1,100 mm clearance between equipment items shall be allowed for maintenance access. The Contractor shall indicate on the general arrangement drawings where larger clearances are required. An absolute minimum of 600 mm clear access shall be provided with all access doors open in any position. The designer shall not adopt this minimum 600 mm clearance provision unless providing the nominal minimum 1,100 mm clearance is proven impracticable. In such cases, the justification for the decision must be explained in the design report.

For mechanical installation where it is necessary to provide access platforms the platforms shall be fully conforming to AS1657 and this specification. Provision to get onto and off platforms shall be by stairs. Sloping step ladders and vertical ladders may only be used subject to the Principal’s written approval and only in those areas requiring infrequent access and where stairways are not practicable. The decision to use ladders must be fully explained in the design report.

To avoid bump hazards on walkways, platforms and the like, guard railing (hand railing systems) shall not be used as general support systems for miscellaneous equipment such as instruments, lights and local control cabinets. Such items are required to be provided with their own supports with the base connected to the concrete floor or platform structural elements.

Mechanical equipment installations shall be designed so that machines or maintainable sub-assemblies can be removed without the need to enter a confined space. Wherever possible and practicable, mechanical equipment shall be designed such that whole machines or sub-assemblies can be replaced without specialist personnel.

Platforms that are above other access and work areas must be fitted with protective mesh to prevent objects falling through the mesh. The designer must make particular consideration of the corrosion environment that the platform will be serving and use corrosion resistant materials accordingly. Extreme corrosion environments around the following process elements shall have GRP sub-floor structural elements and GRP platform decking:

* Primary treatment area (screening plant, grit separation);
* Primary settling tanks;
* Biosolids separation plant;
* Outfall areas adjacent to the marine environment.
* Primary sludge thickening plant;
* Any other area where an extreme corrosion micro environment may be created.

## Piping and Connection of Machinery

The design of piping and supports must be arranged to provide for:

Positive isolation, locking and tagging of energy sources to make machinery safe for maintenance activities,

Purging and flushing to make safe for maintenance activities,

Isolation from up-stream and down-stream process to allow maintenance activities on individual parallel, redundant machines to be carried out while other machines remain in operation.

Fast dismantling and removal from up-stream and down-stream pipework work without the need to interrupt the operation of adjacent or parallel machinery.

Convenient access for operation and maintenance of the Equipment. The design of Equipment shall allow quick and unobstructed exit for personnel working around the Equipment.

All indicators and instrumentation shall be located and orientated to be easy to read.

Also refer to Section 5 Pipes

## Mechanical Lifting Aids and Crane Access

The designer must consider and provide for maintainers to be able to access equipment with mechanical lift aids. QUU’s preferred solution if for maintenance service trucks, fitted with jib cranes to be able to be used. Machinery installations that do not have access for maintenance service trucks must be provided with fixed or moving or slewing overhead lifting beams.

This requirement is not only to provide the ability for whole machinery items to be removed, collected and replaced at an installation. Provision for mechanical lifting aids to access a machinery installation may also be required to enable maintenance staff to partially disassemble a machine in place to replace a wear part from the rotating element. For example, replacement of brushes on a screenings washpress.

## Rolling BEARINGS

Bearings shall be to ISO standard design dimensions of modern design and of ball and/or roller type and ample capacity for carrying all thrust and radial loads. All bearings shall be lubricated efficiently and capable of long service without maintenance.

All rolling bearings shall be rated in accordance with AS2729 for a minimum basic rating life (L10) of 10,000 million revolutions. Bearings with non-metallic cages shall not be used.

Bearings shall be adequately cooled to accommodate operation of the equipment in an ambient temperature situation of up to 45oC, under the highest loading conditions, without reduction in calculated load rating or rating life. This shall be achieved without special or additional cooling arrangements, such as water cooled heat exchangers or similar.

The Contractor shall supply all mechanical equipment with the correct lubricants for at least one year's operation. The equipment shall also be adequately lubricated to prevent corrosion during storage and installation and for starting and commissioning the plant. Lubricants shall be as recommended by the relevant equipment manufacturer.

Plates indicating the type of oil or grease, quantity and change period shall be fixed to the equipment items adjacent to the oil or grease lubrication points. Plates shall be engraved stainless steel grade 316, fastened with stainless steel fixings.

All bearings shall be capable of maintaining their seal without degradation or decrease of seal capability, eg. loss of seal element effectiveness due to higher than rated peripheral speed or due to axial shaft float. Seals shall protect against ingress of water and foreign matter and from egress of lubricant. Where locking collars are required to maintain seal element tension these shall be of grade 431 stainless steel. Locking screws shall be 'Loctited' at final adjustment.

The Contractor must take precautions to prevent damage to bearings (work hardening or 'brinelling') due to vibration during transportation, such precautions may include, but may not be limited to, supporting shafts within packaging, ensuring that vibration is minimised during transport, final assembly of machinery on-site.

All bearings of machines larger than 500kW shall be fitted with accelerometers. Thrust bearings require monitoring in all three planes, while for other bearings the accelerometers shall cover the two radial planes. The accelerometers shall be used for continuous on-line vibration monitoring, warning and shut down when vibrations exceeds pre-set maximum levels. Vibration monitoring system shall be design in accordance to API670. All bearings of machines larger than 500kW shall be fitted with RTD temperature sensors wired to monitoring, warning and shut down protection system.

Temperature detectors shall be 3-wire, 100-ohm resistance type PT100. All three wires from each temperature detector shall be wired back to the associated auxiliary terminal box on the motor.

## Lubrication

All bearing housings shall be fitted with seals and shall be grease or oil lubricated. Grease nipples with captive screw caps shall be provided for all grease lubricated bearings and where practicable, capillary tubing shall be run from the bearings and grouped at a convenient accessible location. Where grease lines are fitted they shall not be attached to removable parts. Bearing housings shall be fitted with pressure relief devices to prevent over pressure.

Oil lubricated bearings shall incorporate the following:

* An integral oil circulation system. The design of the circulation system and venting arrangement shall not allow escape of oil from the bearing.
* A large capacity adjustable constant level oil make up system.
* An oil level indicator.
* A permanent marking of normal oil level on the bearing housing adjacent to the oil level indicator.

Where continuous grease or oil feeding is required, the capacity of the reservoir shall be sufficient for not less than 14 days continuous service, with indications in the form of meters or alarms.

All bearing blocks in wet areas shall be thoroughly hand packed with water resistant grease, with the grease injection point located diametrically opposed to the vent plug so that new grease being forced in from the top will eject any water that may have entered the bearing block.

Grease injection points and plugs shall be from 316, or higher grade stainless steel and shall be installed with PTFE tape or paste in the thread to facilitate periodic removal. Hex socket drive plugs shall not be acceptable Hex head plugs only.

All grease injection points must be able to be safely accessible from platform level. Achieving this requirement may require grease tubes to be extended to a suitable easily accessible location. Grease tubes must be suitably supported and protected. If saddles and “P” clips are used to support grease tubes, these must be from 316SS. Fasteners and fixings used to attach “P” clips and saddles must be from 316SS and must not penetrate protective coatings on plain carbon steel parts and structures.

All gearboxes, and other equipment with oil bath type bearing frames and oil sumps shall have a means to easily check the oil level and top up or fill with the machine in place as well as, allow for lubricant drained and changed. As a minimum provision, all lubrication drain points shall be fitted with a stainless steel grade 316 drain tube and ball valve with a plug to make it easy for maintenance staff to drain out the lubricant with the machine in place.

## Machine Mounting

For machines with separate foot mount motors, the machine and motors units shall be mounted on a common rigid base frame. The base frame shall be fabricated steel, fully welded and adequately braced to resist maximum operating motor torque and maintain accurate vertical alignment of the driven machine and the motor. The minimum protective coating requirement for all steel skids, machine frames and mounting bases is hot dipped galvanizing to a minimum of 600g/m3.

Landing surfaces on base frames shall be machined to receive the driven machine and the motor to facilitate accurate driven machine and driver alignment. Packing shims shall be 316SS. Jacking plates and screws shall be provided on the base frame to facilitate horizontal alignment of the driven machine and the motor.

Machinery skids, frames and mounting bases shall be securely and rigidly bolted to the machinery area floor slab. A raised concrete plinth may be required under the machinery skid, frame or mounting base to take up level differences or if the machinery area floor is outdoors or is in an area that is likely to be wet or require frequent washing down. Any such raised concrete plinth must include steel reinforcement with a minimum of at least one continuous N12 steel bar loop surrounding all base hold down bolts and dowel/starter bars connecting the plinth to the floor slab.

The design of machinery installations shall be in accordance original equipment manufacturer’s recommendations..

Rotating machinery likely to be a source of vibration such as positive displacement blowers and pumps or reciprocating machinery should have flexible connections between the pipework as well as vibration isolation mounts to prevent vibration being propagated through pipes and the building structure.

## Bolts and Fastenings

Bolts and screws shall be in accordance with AS 1111. Washers shall be in accordance with AS1237. Nuts shall be in accordance with AS 1112. Nuts, bolts, washers and screws shall be stainless steel where they may be exposed to sewage, sludge or a corrosive environment. Galvanised bolts must be used in applications where the environment is determined to non-corrosive. High strength phenolic insulating washers or equivalent shall be fitted under metal washers and bolt heads, adequate bolt stem insulating sleeves and suitable gaskets shall be used when dissimilar metals are being fixed or joined in locations that are likely to be wet from time to time.

Nickel based anti-galling or anti seize compound shall be applied on all 316SS nuts before installation. If in contact with potable water the anti-seize compound shall comply with AS 4020.

Grade 316 stainless steel bolts (A4.7) shall be used for all anchor bolts embedded in concrete and Grade 316 stainless steel bolts, with Grade 316 stainless steel (A4.7) nuts and washers shall be used in all submerged situations. Metal free anti-seize grease/compound shall be uses for assembly of all machine screws and bolts.

Flange bolting shall be in accordance with AS2528 and the equipment manufacturer’s recommendations and AS4087. Flange bolts in high corrosive environments shall be A4.7.

A flat metal washer shall be fitted under each nut. Washers shall be tapered where necessary to give the heads and nuts of bolts a satisfactory bearing surface. The threaded portion of each bolt shall project through the nut by at least two full threads and not more than a distance equal to the bolt diameter.

All bolts and nuts used in pump construction shall be machine faced and seatings for bolt heads and nuts on castings shall be spot faced. Where nuts are liable to work loose due to vibration, self-locking nuts or other approved locking devices shall be used. Black metal spring washers are not acceptable. Fixing of cover and access panels shall be by means of A4.7 machine screws into tapped holes. Self-tapping screws shall not be used.

Unless stated otherwise, all bolted connections on mechanical installations shall be designed and tightened to be reusable.

All other fasteners shall be high strength steel bolts for structural engineering class 8.8, with steel nuts class 8 and associated hardened and tempered steel washers, all complying with AS1252. All threads shall be ISO metric coarse pitch series. Bolting category shall be 8.8/TB (full tensioning) as per AS4100.

The bolts and nuts shall be hot dipped galvanised in accordance with AS1214 and washers in accordance with AS4680.

Electro galvanising, nickel, cadmium, chrome or any other plating process shall not be used.

All fasteners M10 and above shall carry markings of the manufacturing source (manufacturer’s identification symbol) for product traceability.

## Chemical Anchors

Ramset, Chemset injection 801 adhesive, maxima spin capsules, or similar high strength, high duty chemical anchor epoxy stud adhesive shall be used according to manufacturer’s design ratings and design loads. Chemical anchor studs must be 316SS minimum. Selection and sizing of chemical anchor studs is considered part of the structural engineering design. Details must be shown on the structural detail drawings. Design calculations for bolted connection must be supplied for review upon request by QUU.

Mechanical anchors are not allowed unless written approval is provided by the Principal.

## Equipment Data for Design and System Integration.

Mechanical equipment manufacturers and suppliers must provide complete data sheets containing details of all the necessary design parameters, to enable integration into the process train as well as design of all necessary supporting equipment that is needed for the construction, operation and maintenance of the supplied machinery. Such supporting sub-systems may include but may not be limited to:

* Provision for flushing and drainage,
* Wash water,
* Cooling and ventilation system,
* Compressed air supply,
* Power,
* Communications

## Ventilation

### General

The Contractor shall be responsible for the design, supply, installation, testing and commissioning of all the ventilation systems for the new Plant including all buildings and process equipment as described in this Specification.

Unless otherwise specified, ventilation ductwork, fittings and appurtenances shall be designed, supplied and installed in accordance with AS 4254.

All ductwork shall be grade 316 stainless steel or fibreglass or PVC. PVC shall only be used up to 100 mm diameter where H2S gas is present. All other equipment like fans or dampers shall be corrosion resistant material.

### Ventilation Fans

Fans shall be 3 phase, 415V, industrial quality, axial or centrifugal type, with 316 stainless steel casing. The fans shall be selected to achieve the lowest practicable absorbed power at the nominated operating conditions. Grade 316 stainless steel safety guard shall be provided on unducted fan entry colars. Fan installation configuration shall be n+1.

Fan motors shall have non-overloading power characteristics. Fans and motors shall be selected with at least 10% extra capacity. Terminal boxes external to fan casings and wired to fan motors shall be provided.

Fan performance test curves with the operating point clearly indicated thereon, shall be provided for each of the fans and shall be incorporated in the Operation and Maintenance Manual. The performance curves shall be based on tests carried out in accordance with AS 2936.

### Installation

Fans and accessories shall be arranged to allow service access for maintenance and removal, and for replacement of assemblies and component parts, without disturbance of other items of plant.

Flexible connections shall be provided to prevent transmission of vibration to ductwork. Where necessary, expansion pieces between fans and flexible connections shall be provided.

## Noise

### Measurement Method

The overall sound pressure level during operation of any item of machinery shall be measured at a distance of one metre.

The sound pressure level shall be measured with a precision sound level meter conforming to AS1259, or AS IEC 61672 or any subsequent amendments.

Supply full details of the test procedure, conditions and standards used for any figures guaranteed prior to conducting the tests.

### Noise Characteristics

Noise emissions from any item of equipment shall be broad band, non-tonal, continuous, non-impulsive and non-step-wise variable. Definitions of these terms are as normally understood and are as given in AS 1055 and under both the environmental and workplace noise regulations of Queensland.

If not otherwise agreed in writing with the Principal, the free field sound pressure level at 1.0m from the Plant/Equipment shall be no more than:

70dB(A) for any single item running under any operating condition.

75dB(A) for a complete system with all duty units operating under any operating condition.

Plant /Equipment shall be designed and installed such that full account is taken of the installed location of the Plant/Equipment (i.e. exposed to the weather or under cover, height above ground, possibility of sound break out or amplification in connecting pipes and supporting structure).

### Occupational Noise

As the WHS Regulation 2011 states that an employer must ensure that appropriate control measures are taken if a person is exposed to excessive noise levels, the following maximum occupational noise levels shall be adopted for the plant supplied and installed under this Contract:

1. L Aeq, 8-h shall not exceed 85 dB(A); and

2. LC,peakPeak shall not exceed 140 dB(C)

In addition, under normal operational conditions the maximum noise produced by installed equipment shall not exceed an overall A-weighted sound pressure level LAeq, (SPL) of 85 dB(A) when measured at no further than one metre from the operating unit.

The measured noise levels shall include room reverberation effects and any other noise associated with the supplied equipment.

### Soundproofing Enclosures and Devices

Acoustic enclosures should be used only if accepted by the Principal.

If the Contractor provides an acoustic enclosure, then the enclosure shall form an integral part of the equipment and shall not adversely affect the safety or function of equipment.

The soundproofing enclosure shall not impede the flow of cooling air when fully installed.

The acoustic enclosure shall be constructed so that it can be easily removed for maintenance purposes, e.g. to be wheeled across the floor. The enclosure shall have locks / latches to keep the enclosure closed when it is over the equipment.

Normal operation shall be possible without opening or removing enclosure. Hinged access doors shall be provided on all sides for easy access for routine inspection and maintenance.

Flammable materials must not be used for sound proof enclosures.

# Safety

## General

All equipment shall be designed to afford maximum protection and a safe working environment for operating personnel.

Inspection covers shall be readily opened without the use of tools. Grills, bars or mesh shall be provided behind covers where moving equipment may be reached. Alternatively, interlocks shall be provided to stop equipment in the event that covers are opened.

Safety warning siren for warning and preventing accidents shall be provided when equipment, such as conveyers, start moving automatically.

## Guards

All moving shafts, couplings, flywheels, belt drives etc. shall be fully guarded in conformance with the relevant Queensland Work Health and Safety Act, Regulation and Codes of Practice and Australian Standards (including AS 4024). Guards and protective barriers shall be provided eliminate the risk of body parts from getting into any crush or pinch points machines or contact with hot surfaces.

Guards shall be designed to provide ready access to bearings, greasing points and other check points. Hinged doors built into the guards with adequate fastenings shall be provided where necessary to facilitate access to check points. Grease points shall be extended to outside of the guard.

The minimum requirement for fixing and attachment of removable guards and barriers is, metric M6, Coarse Pitch, A4.7, (316SS), Hex head, machine screws, drilled and tapped into the holding structural support or holding framework behind. Fastening machine screws shall be fitted with a flat 316SS washer. The requirement is for these connections to be reusable many times. Attaching guards or removable barriers with rivets or self-drilling screws is not allowed.

Covers for items requiring frequent inspection (more than 10 times per year) shall be lockable but apart from the need to unlock the cover, shall be able to be opened without tools unless otherwise agreed in writing with the Principal. Such covers shall also be fitted with an electrical interlocks to AS4024.1601~1603:2014, to shut down the equipment and fitted with permanent warning signs.

Where frequent inspection of moving parts is required but access is not normally required, the cover shall be transparent to allow inspection without removal of the cover. Where mesh is used the apertures shall be small enough to prevent body parts (especially fingers) reaching the moving parts. Additionally, the mesh aperture shall be such that tools, debris other foreign matter that could harm the moving part cannot pass through the mesh.

The equipment shall be provided with guards in accordance with the all requirements of AS 4024 and no removable section of guard shall exceed 16 kg in weight.

Guarding shall be effective when acoustic enclosures are temporarily removed.

Guards, cowls including mesh guards, shall have corrosion resistance and strength to withstand the installed environment as well as any reasonably foreseeable normal or abnormal load or exposure during operation or during maintenance and inspection activities. Where guard panels are incorporated into walkway hand rails, the resultant assembly shall be fully conforming to AS1657. Mesh guards that are intended to allow operators to see moving machinery parts shall be painted matt black minimise reflected light and make it easier for operators to see through the mesh.

Appropriate workplace health and safety warning signs complying with AS 1319 shall be fastened to all equipment.

## Safety Signs

Safety and warning signs shall comply with AS1318, AS1319, AS2508 and AS2927, as applicable, and shall be installed where necessary.

The signs shall warn of potential hazards, assist in preventing accidents and give operational and emergency procedures for potentially hazardous situations. Signs shall provide warnings where equipment may start automatically, where equipment may move without warning and where other potential hazards may occur.

Warning siren and beacon light shall also be installed for equipment where potential hazard may occur when equipment start automatically or fail to start.

The contents of piping, conduits and ducts shall be identified as per AS1345. Arrows shall be provided to show the direction of flow.

## Safety Interlocks

Necessary safety interlock devices shall be provide to facilitate protection of operating personnel, as well as to prevent damage to the mechanical portions of the equipment.

## Fail Safe

All items of equipment shall be designed for safe operation.

The machinery shall be designed to leave the plant in a safe condition in the event of any failure in part of the machinery or its associated safeguards, control circuits or its power supply.

## Over and Under pressure Protection

Mechanical Systems, pumps in particular, shall be protected from damage through accidental or process related stoppage of the suction or discharge systems. Over-pressure protection requirements may include a resettable over centre cam type, mechanical relief valve, with the exhaust from the relief valve directed to a location where the discharge will not create a hazard or nuisance. The relief valve shall maintain a positive resilient seat with no partial passing until the set point pressure is reached. The relief valve set point shall be selected as a final protection for the pump and pipework from mechanical damage. Primary over-pressure protection shall be provided by high and low pressure switch motor interlocks. Motors shall also have thermal overload protection in accordance with TMS1200 and TMS1222.

## Protection from Vehicles

The Contractor must provide corner protectors, protective barriers or bollards to protect structures, equipment and personnel from moving vehicles. Such protective devices shall comply with relevant Australian Standards, including but not necessarily limited to AS1318, AS1742, AS1906, AS2890 and AS3845.

Unless specified otherwise, all bollards shall be min. 140mm diameter x 1200mm high and painted yellow in accordance with AS1318, with a min. 50mm wide reflective top band.

# Protective Coatings

## General

The site shall be classified as Category C5-I Atmospheric Industrial Zone (Very High) as defined by AS/NZS 2312.1:2014. The environment for steelwork subject to immersion shall be designated as Sewage immersion for non-atmospheric environments (Table C1 AS/NZS 2312). However, for new work, stainless steel grade 316 should be used where the part is subjected to immersion, sprays or splash, also refer to Section 2.9.Materials.

## Fabricated Steelwork and Pipework

Prior to the commencement of any work associated with the preparation or application of protective coatings the Contractor shall provide evidence to the Principal that:

The company engaged to carry out the work has a Quality Assurance system accredited to ISO 9001; and

The personnel who will be undertaking the work have appropriate trade qualifications and certifications from the relevant coating system Mechanical Equipment Contractors.

If the Principal considers that evidence provided is unsatisfactory then the Contractor shall seek an alternative company to carry out the work.

All fabricated plain carbon steelwork and iron parts and exposed metal pipework surfaces shall be coated with the exception of the following:

1. Machined surfaces, which shall be protected during blasting and painting. These surfaces shall be treated with protective film after painting is complete to prevent corrosion prior to being assembled.
2. Stainless steel plated and galvanised surfaces unless specified otherwise. Galvanised piping shall be painted for identification of contents;
3. Grease fittings, hose fittings, valve stems, gauges and similar;
4. Concealed galvanised or metal sprayed surfaces;
5. Stainless steel surfaces;
6. Aluminium surfaces;
7. Chains and sprockets; and
8. Nameplates (including manufacturer's nameplates and data plates), which shall be protected during blasting and painting, and cleaned and buffed to leave wordings clearly legible.

Where the surfaces are coated it is mandatory that:

1. All holes have been drilled and welds completed before surface preparation is undertaken; and
2. All sharp edges, burrs, slag, weld splatter, tack weld remnants, or other sharp surface irregularities shall be removed by grinding.

## Protective Coating Systems For Iron and Plain Carbon Steel.

Protective coating systems on iron and plain Carbon steel structures and parts must be as detailed in Table 1 - Protective Coatings Requirements below:

Table - Protective Coatings Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Requirement |  |  |
| Corrosive environment category | Category C5-I, Very High, Atmospheric Industrial as defined in AS/NZS 2312.1:2014 |  |  |
| Required system life | The protective coating system shall be designed and applied to give a minimum of 15-25 year life before recoat is necessary. |  |  |
| Preparation system for new parts, parts where the protective coating has been lost and parts with flaking non-adherent paint | Where the surface to be coated is corroded, the preparation process will be by a blast-wash-blast process, to achieve an uncontaminated class 2.5 clean surface with a sharp angular surface profile of 50 to 70 microns. Where necessary, some small areas may need to be prepared using a small hand blaster, a bristle blaster, abrasive flapper disk or other suitable method. Generally, the use of a hand grinder to remove corrosion is not approved because it will result in excessive material removal.  Preparation must be carried out in full conformance with Environmental Protection Regulations, with regard to containment of abrasive blast product and paint particles. |  |  |
| Preparation where existing paint is still tightly adhering to the part | Areas of existing stable paint surrounding corroded areas shall be roughened and feathered back using a light abrasive sanding paper or abrasive flapper disk. Areas where paint is flaking, is lost, or is showing signs of rust, shall be prepared as for new parts or bare metal parts above. All well adhered, aged, painted surfaces that are to be recoated shall be roughened to provide a physical "keyed" surface profile. |  |  |
| Areas where original galvanising is still present | Areas where galvanising is still present shall be prepared by a light whip blast to provide a physical "keyed" surface profile, prior to application of a holding/tie coat and full coat. |  |  |
| Protective coating system full coat | AS 2312:2002 EHB2 system to a minimum total DFT of 400 micron (minimum). The requirement is for a surface tolerant, MIO, high build, high solids, high hardness, 2-pack, epoxy, such as Interzone 954 or Interplus 1180. It is envisaged that the product will be applied as 2 x 200 micron (minimum) airless spray or roller/brush applications and strictly in accordance with all manufacturer’s requirements. The Contractor shall provide full product details, reasons for selection and obtain approval for proposed products in writing. |  |  |
| Holding coat/primer coat/tie coat. | An epoxy zinc phosphate tie coat, 50-75 microns DFT, shall be used on all areas which have previously been galvanised or have been prepared to bare metal. The Contractor shall provide full product details, reasons for selection and obtain approval for proposed products in writing. |  |  |
| Coating system application | The protective coating system may be applied by all methods of application, e.g. brush, roller airless spray.  All external edges weld seams, nuts, bolt heads, crevices, holes, corners and other difficult to access areas shall be stripe coated by brush application, prior to spray or roller application of full coat. |  |  |
| Colour | All steel structures shall be light grey MIO to match existing equipment. |  |  |

All coating systems shall be applied strictly in accordance with the requirements, written instructions and recommendations of the coating manufacturer.

### Hot-Dip Galvanising

Hot-dipped galvanised coatings shall comply with the requirements of AS/NZS 4680. Average coating mass shall not be less than 600 g/m². The composition of the zinc in the galvanising bath shall not be less than 98%.

All articles to be galvanised shall be handled in such a manner as to avoid distortion and mechanical damage. Where welding or flame cutting of galvanised components is used during installation the coating shall be reinstated in accordance with AS/NZS 4680 Appendix E.

### Handling of Finished Parts

Painted metalwork shall be handled with care to prevent damage to the coating. It shall not be handled until the paint has dried hard, and in the case of epoxy resin based paints, until the final coat has cured for three days.

To prevent damage to the paint:

1. Slings used for handling the painted steelwork shall be covered with a soft material; and
2. Supports in contact with painted steelwork during transport or storage and temporary supports during erection shall be coated with soft material.

All finished product shall be thoroughly inspected for damage to painted surfaces prior to installation. All damaged paint shall be repaired to restore the full protective barrier to the specified thickness. The colour of the protective coating repair shall match the colour of the part being repaired.

### Records

Records shall be maintained to provide effective traceability of workmanship and materials. These records shall be maintained on a daily basis and as a minimum shall include:

1. Job identification;
2. Surface preparation and equipment used;
3. Coating applied and equipment used;
4. Material used, batch number, colour;
5. Application details including coat number, wet film thickness and dry film thickness;
6. Weather conditions;
7. Time and date;
8. Applicator name and identifier; and
9. Inspector name and identifier.

## Mechanical and Electrical Equipment

The Contractor may rely on the manufacturer of mechanical and electrical equipment, such as motors, bearing blocks, gear housings, to select and apply protective coatings to their product based on the environmental classifications nominated in Section 4.1. In such case, the Contractor shall submit details of protective coatings to the Principal, for acceptance in writing prior to placing their order with the Supplier.

If necessary, the Contractor shall have custom protective coatings applied to new equipment or apply after manufacture coatings to augment standard factory coatings where standard factory coatings do not meet the minimum thickness specified in Section 4.3 Protective Coating Systems For Iron and Plain Carbon Steel.

# Pipes

## Pipes General

Design, construction and installation of pipelines, pipework and valves shall be in accordance with QUU document TMS1435 “Technical Specification for Design and Construction of Water and Sewerage Main Systems”.

## Pipeline Requirements

This specification applies for all above ground pipe work. This specification excludes buried pipe work. Requirements for buried pipe work are given in TMS1435, which covers civil works.

Buried pipework and out of ground pipe that is conveying, potable water, raw sewage, mixed liquor, effluent water and other grades of recycled water will be deemed civil works and shall be designed in accordance with TMS1435. Final run connecting pipe from the above civil works pipework may be considered as Mechanical works, however life time and durability considerations must be the same as the requirement for Civil Assets. Aeration air mains shall be suitable for a minimum of 50 years.

New pipelines on treatment plants shall have:

* Labelling as per AS1345 Identification of the Contents of Piping, Conduits and Ducts
* Rodding eyes for pipes conveying thickened process fluids (i.e. RAS, WAS, scum etc.); and
* Isolation valves on every branch connection.

Pipework shall be designed and installed to:

Be thrust resistant and adequately braced under all load conditions;

Include valves, flange connections, dismantling joints and adequate pipe supports to allow for easy dismantling and re-instatement of each section of pipework;

Enable manual flushing;

Eliminate dead ends and stagnant sections;

Include blind flanges and fittings as required to facilitate testing of pipe sections;

Include isolation valves at every branch (unless authorised otherwise), and at all operating equipment to allow for the equipment’s safe removal;

Not restrict access to mechanical equipment, electrical equipment or instrumentation;

Provide safe access for monitoring and maintenance of in-line instrumentation and operation and maintenance of equipment (including all primary isolation valves) from the finished surface levels where feasible, and access platforms otherwise;

Minimise the number of access platforms without restricting access to equipment; and

Not interfere with the safe removal of equipment by crane or hoists.

Allow for thermal expansion across the maximum foreseeable temperature range.

Allow for differential settlement at locations where pipelines transition from buried to out of ground pipe, supported from structures.

All gravity drain lines carrying suspended solids shall be sloped to effect re-suspension. Inspection chambers/manholes shall be provided at both changes in direction or alignment in gravity drains in accordance with the applicable QUU standard drawings.

Detectable marking tape appropriately coloured and lettered compliant with AS2648.1 and AS2700 shall be provided for all underground non-metallic pipework and laid on top of the pipe embedment.

Where pipelines are connected to structures, two flexible joints shall be provided within:

* 900 mm of the structure for pipes up to 300 mm internal diameter,
* 1800 mm for pipes over 300 mm internal diameter and up to 600 mm internal diameter,
* A distance agreed in writing with the Principal for pipes with an internal diameter of greater than 600 mm.

Pipes and fittings encased in concrete are considered as structures.

## Flanged Joints

Flanges for general, out of ground water works pipelines as outlined in Section 5.2 Pipeline Requirements, for pipework shall:

* Be to AS4087.
* Be drilled off centre; and
* Be joined in accordance with Appendix E of WSA 109 and Appendix C of AS4087.

Where flanged pipework is to be connected to existing flanged pipework the Contractor shall determine the size, class and bolt hole drilling pattern prior to ordering the new pipework.

Gaskets for flanged joints shall comply with WSA 109.

## Pipe Supports

Out of ground pipe lines must be supported on fabricated, hot dip galvanized mild steel brackets dry or rain washed, low corrosive areas. Brackets in more corrosive environments, with close proximity to the coast or subject to subject to H2S from the decomposition of sewage, or splashing from water, sewage or mixed liquor shall be manufactured from 316SS. All pipe supports must be detailed on the drawings. Drawings must show pipe supports on racks or by anchor brackets as well as saddles, supports, fasteners and protective coating systems. The design shall be subject to approval in writing by the Principal.

Sliding supports or pipe racks shall be provided in each direction at each change in direction. Sliding supports, racks, saddles and supports shall be of standard manufacture for that purpose. All anchors shall be stainless steel grade 316, chemical type. Sliding supports shall have 12x45mm, polyethylene strip, mechanically fixed to the top of the sliding bracket to prevent wear of the bracket or the pipe.

Pipe supports in floor trench drains in buildings shall be of stainless steel grade 316, FRP, PE or other corrosion resistant material.

Anchorage shall be provided where there is the possibility of pulling joints or subjecting pipework to excessive stresses. Pipe anchorages shall be provided to absorb static and dynamic thrusts from pipe fittings and valves. Pipeline designs must allow for differential movement at transitions between structures with separate foundations or between structures and buried pipelines.

All pipework with joints not designed to withstand tensile forces tending to separate the joint when the pipeline is subjected to an internal gas or liquid pressure, shall be fitted with thrust and anchor blocks, or (tie-rods for out of ground pipelines) at all intersections, branches, changes of direction, valves and dead ends.

## Piping Materials

The Project Specification may specify the required pipe material. If not specified, the Contractor’s Design Engineer shall be responsible for the selection of the pipe material. However sufficient information must be provided to satisfy the QUU Representative that the selected pipe material is the most suitable for the particular service and installed environment. The pipe selection information submitted with the proposal shall, at a minimum, include a complete specification of the material and shall address the following considerations:

1. The compatibility with the service fluid and operating conditions.
2. Resistance to sunlight (UV radiation).
3. External resistance to sulphuric acid attack, caused by airborne hydrogen sulphide gas.
4. The pipe MAOP compared to the maximum fluid operating pressures.
5. Pressure de-rating with temperature.
6. Allowable pipe spans.
7. Design life.
8. Any other service condition that is likely to have an effect the durability of the pipe material.

Written approval from the QUU Representative must be obtained prior to ordering an alternative pipe material.

If proposed at the point of tender, the alternative pipe material shall be clearly identified as an alternative offer. The conforming offer shall be based on the pipe material nominated in this document.

## Stainless Steel Piping

Stainless steel pipe shall not be used for buried service. Where transitions from above ground pipe to underground pipe in 316SS material is unavoidable, the SS pipe and connecting flange shall be fully wrapped using a complete Denso Petrolatum System consisting of priming grease, putty to eliminate voids, wrapping bandage, PE external over wrapping tape, to provide and effective moisture barrier.

The 316 stainless steel piping shall be designed, manufactured, installed, tested and commissioned in accordance with AS/NZS 4041, AS4037, and AS1579. Stainless steel pipework provided for QUU facilities must also be as per the following requirements in Table 2- Stainless Steel Pipe Requirements.

Table - Stainless Steel Pipe Requirements

|  |  |  |
| --- | --- | --- |
| Service | For out of ground sections of pipe conveying most process fluid mixtures on STPs.  Not suitable for buried service or for low pH anoxic environments or fluids. Contractor to confirm chemical and service compatibility. | |
| Size range: | DN15 to DN750 | |
| Pipe: | ASTM A312 TP316L and ASME B36.19.  From DN15 to DN40: SMLS pipe, BSP threaded ends  From DN15 to DN50: SMLS pipe, butt weld ends  From DN80 to DN200: SMLS pipe, butt weld ends  From DN250 to DN750: EFW pipe, butt weld ends | |
| Fittings: | From DN15 to DN40: A182 F316L, B16.11, socket welded or BSP threaded ends  From DN50 to DN750: ASTM A403 WP316L and ASME B16.9, butt weld ends. | |
| Flanges: | AS4087  Flange material grade: ASTM A240M 316L  Flange class designation: PN16 | |
| Nominal Wall Thickness (minimum) | Where operating pressure will not exceed 700kPa and pipe wall temperature will not exceed 60oC. | |
| DN15 to DN50 | Schedule 40S |
| DN80 to DN750 | Schedule 10S |
| Weld Finish | Grade II Finish, in accordance with AS1554.6 | |
| Pressure Testing | Hydrostatic testing in accordance with AS4041 | |
| Weld Examination | Non-destructive examination requirement includes: 100% Visual examination of all welds, a minimum of 5% radiographic examination of all butt welds and fillet welds. | |
| Weld Procedure Qualification as per AS579 | Contractor to provide the method of weld procedure qualification with design and prior to fabrication. Examination records are to be provided with documentation. | |
| Proof of Welders Qualifications to be provided. | AS1796 Certification of Welders and Welding Supervisors | |

The Contractor’s Design Engineer is responsible for checking whether the above stated pressure and temperature are adequate for the service conditions. If necessary, the Contractor shall specify 316 stainless steel pipes and fittings with higher pressure ratings.

All 316 stainless steel components shall be supplied in the solution annealed, heat treated condition. All 316 SS components shall be cleaned and passivated. Cleaning and passivation treatment shall be applied during manufacture and also after any on site fabrication works.

Where a weld needs to be carried out on a pipe place that cannot be effectively cleaned and passivated after welding, back gas purging with inert gas shall be used to prevent oxidation on the inside surface of the pipe to provide maximum corrosion resistance for the new pipes. All other welds must be mechanically and chemically cleaned prior to passivation to provide maximum corrosion resistance.

The Contractor and the Contractor’s Design Engineer must address the risk of external contamination of the stainless steel pipe. For example, if the Design Engineer determines that the stainless steel pipe is to be supported from galvanised steel support brackets, the galvanised steel support brackets must have a UHMWPE strip mechanically fixed to the support bracket and PE tube must be fitted over the “U” bolts to prevent interruption of the Chromate layer on the stainless steel by iron oxide from the plain carbon steel support brackets.

### Thermal Expansion

All pipes subject to ΔT over 20⁰C must be checked for thermal expansion. Expansion bellows and expansion joints shall be included to absorb angular, rotational and axial movement.

# Valves, Penstocks and actuators

## Valves

### General

Unless specifically required for plant function, valves shall be sized at or above the nominal pipe size. All valve bodies shall be suitable for the maximum pressure as specified, including test pressures.

All machine screws and bolts that are used on the valve assembly shall be A4.7 (316 SS cold formed bolts with markings), and shall be assembled with metal-free, marine industry approved anti-seize compound/grease. The Contractor’s Design Engineer must consider the valve construction and materials with regard to the process fluid and the external environment that the valve is likely to be subjected to.

Wafer type valves may not be used for isolation and servicing of system components or where pipe on either side of the valve may need to be removed during maintenance events while it is likely that the pipe on either side of the valve will need to remain charged.

Tapped lugged type valves suitable for bolting between flanges with stainless steel grade 316 machine screws shall be used where the valve may be required to isolate the pipeline and allow dismantling of the pipework on the isolated side of the valve;

All valve assemblies exceeding 25kg shall be provided with lifting attachments. Such lifting attachments must be designed and rated for lifting the entire mass of the complete valve/gearbox/actuator assembly.

### Extension Spindles and Hand Wheels

The designer shall endeavour to eliminate the need for extension spindles, however, where the use of an extension spindle is the most practicable alternative, extension spindles of valves shall be of tubular stainless steel grade 316L, with one end secured to the valve spindle and the other end made to accommodate a stainless steel grade 316L hand wheel. Additional radial support of the extension spindle may be required.

Extension spindles exceeding 1.5 m in length shall be supplied with stainless steel grade 316L intermediate support brackets bolted to the concrete structure using stainless steel fixings.

Hand wheels shall be sized to operate the valves and penstock gates under all operating conditions throughout the full range with no greater than 120 N force applied to rim of the wheel.

Hand wheels, extension spindles and handles shall display an a stamped or engraved arrow, together with the word "open" and/or "close".

Chain-wheels shall be subject to acceptance, and only used where access platforms are not practical. In such cases the chain and wheel shall be from 316SS.

### Butterfly Valves

Butterfly valves shall comply with AS 4795 and the following requirements:

1. Butterfly valves shall not be used on sewage lines or lines carrying materials likely to rag or otherwise accumulate on the valve disk and shafts.
2. Chipping or reducing the cement lining to provide clearance for valve discs or working parts of valves shall not be acceptable.
3. Concentric deep bed groove design with primary shaft sealing on the rubber liner and secondary O-ring shaft sealing to protect the bearings;
4. Be able to open and close under an unbalanced system operating head of up to 900kPa;
5. Resilient seating valves shall generally not be used in applications where frequent operation is required against unbalanced pressures greater than 500kPa. Butterfly valves with fully vulcanised seats may be considered in this application.
6. Have replaceable resilient valve liner in place;
7. Be constructed from materials appropriate for the duty;
8. Be installed with the shaft mounted horizontally wherever possible, with the lower portion of the disc opening in the direction of flow;
9. If required, have a heavy duty right angle geared operator with electro-mechanical actuator and shaft seals to dirt or water entering the gear units. The geared operator shall have a mechanical disc position indicator and mechanical over-travel protection acting on the input shaft side of the gearbox;
10. For sizes greater than DN300 and more critical applications the valve shall be double flanged with fully vulcanised rubber seats;
11. Actuation shall be as per design requirements. For small sizes a double acting lever handle may be used. Lever handles and notch plates shall be stainless steel grade 316. Where the design requires positive isolation, the levers and plates shall be able to be stapled through with a padlock. Locking by stapling the notch plate release is not an acceptable solution where positive, lockable isolation is required.

### Knife Gate Valves

Knife gate valves shall generally comply with AS 6401 and the following:

1. Be suitable for installation in applications subject to submergence in or splashing by sewage or sludge;
2. Have the body, gate, seat, superstructure, gland and all fasteners manufactured from stainless steel grade 316;
3. Have the valve body as a tapped lugged design suitable for bolting between flanges with stainless steel grade 316 machine screws from both sides;
4. Have gland packing manufactured from PTFE impregnated glass fibre;
5. Flange jointing with full face insertion elastomer (typically EPDM) gaskets;
6. Be provided with clear indication of closed and open positions. The indication shall provide a clear visual signal prior to over-tightening or over travel

Where a rising extension spindle is required, the standard factory product may need to be modified by having the factory spindle and lift nut removed, and replaced with a new rising spindle and fabricated stainless steel grade 316L lift support structure and lift nut and screw spindle in the location where it can be easily accessed for maintenance and greasing.

### Gate Valves

Gate valves shall only be used for isolation of pipework and not to control flow. Valves may be either resilient seated to AS/NZS 2638.2) or metal seated to AS/NZS 2638.1. The Contractor shall determine the most suitable seating of valve depending on the fluid, differential pressure and the accessibility of the valve for future replacement versus the acceptability of a small passing flow when the valve is closed. The Contractor shall also determine if a gearbox is required to allow for ease of manual operation. Where a gearbox is used, the gearbox shall include mechanical over-torque protection and a position indicator. Out of ground valves on process fluid pipelines within treatment plant facilities shall be fitted with hand wheels. Buried pipeline valves shall be as per drawing number SEQ-WAT-1301-1.

Isolation valve on trunk water main assets must be Metal seated AS/NZS 2638.1.

### Non-Return Valves

Non-return valves - shall comply with AS 4794. Resilient seated valves shall that effectively seal under the weight of the disc and back pressure are preferred. “Swing-Flex” check valves by Valmatic or similar should be used for most applications.

The Contractor shall consider if the valve may need to have a means of holding the disc in the open position to allow backflow and draining of the system back through the valve for certain maintenance operations. The Contractor shall also consider if the valve requires a visual means of indicating if the valve is open or closed and if the valve needs to be fitted with a switch to provide electronic feedback to the control system.

Titling disc, metal seated type valves shall not be used in pipework carrying high suspended solids or rags e.g. RAS, WAS, Mixed Liquor, untreated sewage, etc.

Duckbill valves for use on through-the-wall pumps shall be Red Valve or similar.

### Ball Valves

Unless stated otherwise on drawings or in the project specification, ball valves used for water, air applications shall be three piece construction with:

1. Stainless steel grade 316 body, trim, fasteners and handle;
2. Orifice size equal to port or nominal bore connector size.
3. PTFE seals and seats; and
4. Pressure rating to a minimum of 1,200 kPa.

### Eccentric Plug Valves

Eccentric plug valves shall be rectangular port type to ensure even seating pressure across the full length of the valve seat. Valve shall have a nodular cast iron body, resilient faced plug, a welded hard nickel seat, stainless steel shaft and seal packing covers and permanently lubricated radial bearings.

## Penstocks

### General

Where not specifically stated otherwise, in the Project Requirements Document, the following requirements and considerations shall apply.

Penstocks shall:

1. Have guide frame and lift pedestal structural frame manufactured from 316 grade stainless steel in accordance with the relevant section of TMS1434
2. Be designed to be opened and close under an unbalanced system operating head;
3. Be flat back, square opening, flush bottom, full frame type;
4. Have a maximum allowable leakage rate of 0.1 L/min per metre of sealing surface at maximum operating head;
5. Be leak tested on site after installation;
6. If wall mounted, have non shrink grout between the penstock and the wall incorporating an embedded hydrophilic water stop seal around the full frame to concrete structure interface;
7. If embedded, have non shrink grout around the frame flush with the concrete face incorporating an embedded hydrophilic water stop seal around the full frame to concrete structure interface;
8. Ensure safe and efficient access taking into account operating locations such as handrails and flooring;
9. Have the gate or door fabricated from plate with stiffening elements;
10. Include replaceable, extruded, UHMWPE low friction, sealing, mechanically located, single piece side guides of 2.0 times the gate height as a minimum;
11. Have all components designed for maximum deflection of 1/720th of span under worst case loads;
12. Have a minimum bolt size, including seal pressure adjustment, of M12 (except for any seal fasteners). Anchor bolts shall be included complete with two nuts and a washer per anchor; and
13. Gate guide/seals shall be able to be replaced with the gate in place. The Contractor’s Design Engineer must make particular consideration on how the Penstock will be able to be maintained.
14. Where confined space entry to a chamber may be required at various intervals in throughout the life of the facility, gates shall be backed up by manually installed stop boards to provide effective double isolation of the chamber.
15. The possibility of a body parts becoming trapped between the gate and other structures or the frame must be eliminated for all actuated penstocks.

### Penstock Design

The basis for design, hydrostatic loads, performance requirements, corrosion environment category, process fluid, performance requirements and other design constraints shall be clearly stated in the product data sheet. Data sheets with thread details and design pressure values shall be provided in the O&M Manual.

Calculations of deflections, operating torques and stem capacity shall be provided by the Contractor if requested by the Principal.

Arrangement, fabrication and installation drawings for all penstocks shall be provided as a conforming QUU project drawing on a QUU standard D&C Title Block with a QUU drawing number. The spindle thread designation must also be shown on the drawings.

### Penstock Materials

Penstocks shall be constructed using materials as listed in **Error! Reference source not found.**

Table Penstock Materials.

|  |  |
| --- | --- |
| Component | Material |
| Frame | Stainless steel grade 316, only. |
| Gate | Marine grade Aluminium or,  Stainless steel grade 316 (stainless steel to be used in areas subject to high wear or where the unit is frequently operated) |
| Stainless Steel Weld Finish. | Grade II Finish, in accordance with AS1554.6 |
| Bolts, Nuts, Washers and Machine Screws. | A4.70, cold formed, with markings. Assembled with metal free anti-seize compound/grease. |
| Bottom seal | Polyurethane, neoprene, or NBR. |
| Side and top seals | Low friction, low wear, resilient backed material such as ultra-high molecular weight polyethylene (UHMWPE) with neoprene backing. Seal profile must be designed for the purpose and is subject to acceptance by QUU. |
| Lift nut | Bronze or non-metallic |
| Limit nut | Bronze |
| Stem | Stainless steel grade 316 |
| Stem cover | Stainless steel grade 316 or clear polycarbonate |
| Hand wheel | Stainless steel grade 316. “Close” and “Open “ direction must be stamped on hand wheel with a direction arrow. |

### Penstock Spindles

Penstock spindle thread shall be a right hand(RH) single start, trapezoidal die or machine cut ACME or DIN103 threads. The thread designation must be stamped on the end of the spindle and on the nut, as well as provided in the drawings and in the O&M Manual.

Stems shall be not less than 28 mm diameter, but in any case shall not have a slenderness ratio (L/r) greater than 200. A limit nut shall be supplied on rising stems and set such that excessive force applied by the operator at closure cannot buckle the stem. The penstock shall be rising spindle arrangement with the lift nut bearing frame pedestal located above coping or platform level in a location where it can be easily accessed for maintenance.

Lift, bearing, spindle and actuation mechanism shall designed as a closed weather proof, durable housing to protect the moving parts from the environment. Manual actuation shall be by a 316SS hand wheel with maximum input rim force effort of no more than 120N. Opening and closing direction arrows must be clearly embedded, engraved, or stamped in the hand wheel and on the top of the lift mechanism. The entire lift bearing and nut mechanism must be able to be dismantled for replacement or repair with the gate in place and from the platform or coping level;

High duty actuated penstocks shall have automatic lubrication and spindles with high tolerance, ground and polished threads. The stress on the threads shall be less than 6 MPa. The drive nut shall be sized to achieve the required thread stress and at least one replacement nut shall be provided for each high duty actuated penstock.

### Stop Boards and Stop Logs

Stop boards shall include suitably designed lifting handles or load rated, lifting lugs.

Small stop logs intended to be installed manually shall include suitably designed lifting handles such that each segment weighs no more than 20kg and can be lifted by two persons.

## Electro-Mechanical Actuators

### General

1. Electric actuators shall be Rotork IQ/IQT/IQM, Limitorque MX or equal product. Electric actuators shall:
2. Have a hand wheel for "Manual" operation which shall display an embossed or engraved direction arrow, together with English language "Open" and/or "Close" legend;
3. Include a clutch to prevent operation of the motor when the hand wheel is engaged, and to disengage the motor drive from the hand wheel when the motor is engaged;
4. Require a force of no more than 120 N force on the rim of the hand wheel for hand wheel operation when unseating and reseating the valve;
5. Include torque sensing and an absolute position encoder to support programmable torque control and programmable end of stroke position feedback, via inbuilt programmable output relays;
6. Be equipped with a control system that will not lose position reference or configuration settings if operated without power supply;
7. Maintain relative actuator/valve position during manual operation with the power supply off;
8. Not be dependent on an internal battery;
9. Be suitable for use on a 415 Volt, 3 -phase, 50 Hz power supply and the motor shall be a three phase squirrel cage induction type having Class "F" insulation to AS 2768;
10. Be designed for at least 50% more operating cycles (opening/closing) per hour than is required under the worst case operating scenario (12 cycles per hour shall be taken as a minimum, with the actuator able to complete two full open and close cycles without pause at the end of the hour);
11. Be equipped for remote operation, and include a "Test/Off/Auto" selector switch as an integral part of the actuator. When "Auto" is selected the local "Stop" button shall still be operative;
12. Include a local mechanical position indicator fitted in the actuator to clearly indicate when the valve or penstock is fully open, fully closed, or in any intermediate position;
13. Have waterproof enclosures forming part of each actuator in accordance with AS/NZS 61439;
14. Have a motor enclosure and actuator terminal box rated to Class IP65 or IP 68 for in pit installations. (Electronics for the valve controller shall have conformal coating and be in a separate sealed compartment to prevent effects from moisture and H2S);
15. Have clear labelling of the terminals on the actuator terminal block corresponding with the identification shown on the manufacturer's diagram of connections;
16. Have a torque rating approximately 50% in excess of that required to operate the valve or penstock under the highest load parts of the valve stroke (typically this is at seating and unseating);
17. Have adjustable torque and limit switches set to protect the valve/penstock, gearbox, and actuator under all operating conditions specified. Quarter turn valves with gearboxes shall have mechanically adjustable end of travel locking nuts to mechanically stop the drive input shaft to prevent over rotation of the valve;
18. Actuators with 3-phase motors must have phase direction protection for the incoming supply and arranged such that it will render the actuator inoperative if the phase rotation of the power is reversed. Alternatively, the phase discrimination relay can correct actuator rotation to suit supply.

Simple Open/Close function actuators shall be provided with the following inputs and outputs as standard:

| Actuator Input/Output | Function | Requirement |
| --- | --- | --- |
| Control supply | 24 V DC supply | If required. |
| Input | Position Control | If Required.  4-20mA control signal. Valve drives to calibrated position plus/minus dead band. |
| Output | Position Feedback | 4-20mA feedback signal to indicate position as a proportion of the valve stroke range. |
| Input | Close | Closes valve while output from PLC is high |
| Input | Open | Opens valve while output from PLC is high |
| Output | End of stroke (opened) | Relay contact open until valve opened |
| Output | End of stroke (closed) | Relay contact open until valve closed |
| Output | Hardware failure | Normally closed when healthy |
| Output | Overtorque | Normally closed when healthy |
| Output | Remote unavailable | Monitor relay will de-energise under the following conditions:  Selector in “Stop/Off”  Selector in “Local Selected”  Lost phase fault  Valve jammed  Motor over-temperature  Normally closed when healthy |

## Pneumatic Actuators

### Air Solenoid Valves

Air solenoid valves shall:

1. Be spool type control valves with 5-port, 2-way or 3-port, 2-way configurations, replaceable with an adaptor plate;
2. Provide high flow capacity to give the pneumatic actuators good response times;
3. Be suitable for mounting directly onto actuators or in a remote box;
4. Include speed controllers with an operating range of 0.25 to 240 seconds, and silencers as standard items with the supply of the valves;
5. Have field replaceable, 24 V DC solenoid coils;
6. Be provided with a manual override button and an energised indicator light;
7. Have a standard connection size of ¼” BSPT;
8. Be fabricated with anodised aluminium alloy body and spool, nitrile O-rings; and
9. Be supplied with certificates of compliance, product verification report and test result certificates.

### Quarter Turn Pneumatic Valve Actuators

Quarter turn pneumatic actuators shall:

1. Be a compact rack and pinion type with double piston, internal air ports, adjustable travel stops and shall be grease lubricated for life;
2. Have a replaceable 24 V DC air control solenoid mounted either directly to the body of the actuator or separately in a remote box;
3. Be capable of having accessories such as solenoid control valves, limit switch units, de-clutchable manual override gearboxes and high visibility indicators attached directly to the body of the actuator;
4. Include pistons complete with anti-friction pads to ensure no metal to metal contact between pistons and the bore of the actuator;
5. Be pressure rated to 1000 kPa for the body and all the fittings;
6. Be selected to operate trouble-free with a minimum actuator air supply pressure of 550 kPa;
7. Have an available torque operating margin at least 30% greater than the required seating or unseating torque (whichever is the greater) of the valve;
8. Have replaceable 24 V DC rated end of stroke position switches for feedback to the PLC;
9. For control valve with modulating function, be supplied and installed with an electronic positioner. The positioner shall be electro-pneumatic type with a 4-20 mA position feedback to the PLC. The positioner enclosure shall be suitably robust for the installed environment, as well as chemical, UV and impact resistant with IP66 or higher level of ingress protection. Where appropriate the positioner controller and control valves shall be remote mounted. Position feedback shall be provided via a non-contact device with minimal hysteresis. Unless specified otherwise, positioners shall hold the valve in position on electrical signal supply or instrument air supply failure; and
10. Be supplied with certificates of compliance, product verification report and test result certificates.
11. Conformal coating of electronics PCB sub-assemblies to address high humidity and H2S in the installed environment.

Quarter turn pneumatic actuators shall be constructed from the following materials:

Table - Electro-Pneumatic Actuator Materials

| Component | Material |
| --- | --- |
| Body | Aluminium. Painted with Polyurethane or Epoxy 2 Pack protective coating system after assembly. |
| Piston | Aluminium. |
| Piston shaft | Stainless steel grade 316 |
| Bearing | Delrin |
| O-rings and seals | Nitrile |
| Machine screws | A4.7 minimum grade hex head.  Metal Free Anti-Seize grease/compound shall be applied during assembly. |
| Mounting frames | Stainless steel grade 316 |
| Position indicator Covers | Clear polycarbonate.  These need to be an inexpensive and easily replaceable part. |

### Linear Pneumatic Valve Actuators

Linear pneumatic valve actuators shall:

1. Be diaphragm or piston style pneumatic actuators suitable for the automation of diaphragm, gate or knife gate valves;
2. Have a replaceable air control solenoid mounted either directly or via a bracket to the body of the actuator;
3. Be capable of having accessories such as solenoid control valves, limit switch units, electro-magnetic positioners and high visibility indicators attached directly to the body of the actuator or separately in a remote box;
4. Include pistons and stems with suitable sealing arrangements such as O-rings;
5. Be pressure rated to 1,000 kPa for the body and all the fittings;
6. Be selected to operate trouble-free with a minimum actuator air supply pressure of 550 kPa;
7. Unless required to be slower for control, have an operating speed to give a gate valve opening and closing speed of not less than 300 mm per minute;
8. Have an available operating force margin at least 30% greater than the required seating or unseating force (whichever is the greater) of the valve;
9. Be supplied with certificates of compliance, product verification report and test result certificates.

Linear pneumatic actuators shall be constructed from the following materials:

Table - Linear Actuator Materials

| Component | Material |
| --- | --- |
| Body | Cast iron/aluminium (anodised)/GRP.  Painted with Polyurethane or Epoxy 2 Pack protective coating system after assembly. |
| Piston | Cast iron/aluminium |
| Piston rod/shaft | Stainless steel grade 316/High strength alloy steel with Hard Chrome surface. |
| Diaphragm | Nylon reinforced neoprene |
| Bearing | Delrin |
| Fasteners | Stainless steel grade 316 (hex head) |
| Shaft seal | Nitrile |
| O-rings and seals | Nitrile |

# Pumps and Pump Station Requirements

## Pump Stations

The Contractor shall design and construct civil and mechanical components of pumping stations in accordance with the SEQ Water Supply and Sewerage Design and Construction Code - Sewage Pumping Station Code

(http://www.seqcode.com.au/seq-sewage-pumping-station/).

## General Requirements for All Pumps

For all pump selections, the Contractor’s Design Engineer and the pump supplier shall review the specific application duty, process fluid and operating conditions when choosing the pump and material options. The Design Report shall contain an explanation of the pump selection decision. The pump selection decision shall be subject to acceptance by the Principal.

## Submersible Sewage Pumps

Submersible sewage pumps used on QUU facilities shall generally conform to the requirements of WSA 101-2008 except where QUU’s minimum requirements are further clarified or modified in the following table which references clauses within WSA 101-2008. The Project Requirements Document may also contain pump requirements.

Table - Submersible Sewage Pumps

| WSA101-2008 Clause | Addendum |
| --- | --- |
| Table 2.1 | Impeller material shall be high chromium abrasion-resistant white iron as per appendix B of WSA 101-2008 |
| 3.1 (d) | Must be suitable for continuous operation while unsubmerged. |
| 3.7.4 | Must have external adjustment of impellor to wear ring clearances |
| 3.7.7 (a) | Two-pole motors may be approved. Consult with QUU if the specific pump duty suits a two-pole pump selection better. |
| 3.7.7.3 | Must be option (b) only |
| 5.2.1 | All pumps greater than 10 kW shall be performance tested in accordance with AS2417 Grade 2 only |

## Progressive Cavity Pumps

The progressive cavity pump installations shall generally conform to Section 2 General Requirements For all Mechanical Installations as well as requirements and considerations listed in Table 7 - Progressive Cavity Pump Requirements:

Table - Progressive Cavity Pump Requirements

|  |  |
| --- | --- |
| Item | Requirement |
| Rotation Direction Markings | The normal forwards flow shaft rotation direction must be clearly and permanently marked on the pump casing and on the gearbox that forms part of the drive unit if it is a separate assembly. |
| Base Plate | The whole pump including motor and drive unit must be mounted on a single, rigid base plate. Refer to Section 2.16 Machine Mounting . |
| Bearings | Include bearings within the pump (excluding motor bearings) selected for a LH10 service life of 100,000 hours in continuous pump operation at maximum rated conditions (calculated in accordance with AS 2729). |
| Temperature of fluid pumped | 15-30°C (unless otherwise impacted by treatment process) |
| Pump period | Intermittent (continuous not accepted). The Contractor’s Design Engineer must consider pump starting conditions and allow sufficient starting torque. |
| Protection from abnormal operation. | Pumps must be protected to prevent damage to pumps and other parts of the system. Refer to Section 3.6 Over and Under pressure Protection |
| Operating speed | Maximum 400 rpm |
| Drive shaft | The pump supplier shall review the application, torque requirements and process fluid to confirm the most suitable coupling and shaft option. The minimum requirement is sealed pin connectors with hardened steel bushes. |
| Rotor | The Design Engineer and the pump supplier shall confirm the material selection based on the application duty and process fluid. The minimum requirement is hard chrome plated hardened tool steel. |
| Stator | To suit application. Wherever the application allows, the pumps shall have a split stator housing cover to allow easy stator removal with the rotor and pump nozzles still in place (i.e. maintain in place). |
| Inspection ports | Required to allow access to the shaft couple. |
| Starting torque and motor drive system requirement | Full rated pump pressure plus 20% |
| Gearbox lubrication | Oil, splash method |
| Seal | The supplier shall review the application and the process fluid. Replaceable or serviceable SiC/SiC, mechanical seals are the minimum requirement for light duty applications without abrasive solids. Higher duty applications with abrasive solids may require a balanced double mechanical seal with external flushing/lubrication fluid. Gland seals are not acceptable. |

## Rotary Lobe Pumps

Rotary lobe pumps shall conform to the following requirements:

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Requirement |  |  |
| Process installation arrangement | In-line, flange to flange, horizontal shaft, horizontal pipe. |  |  |
| Protection from abnormal operation. | Pumps must be protected to prevent damage to pumps and other parts of the system. Refer to Section 3.6 Over and Under pressure Protection |  |  |
| Machine arrangement | Twin synchronised rotor positive displacement pump, using an oil bath synchronising gearbox with an easy system to set up shaft synchronisation and rotors indexed on the shaft by a keyway. All gearboxes shall have means for checking correct oil level and topping up with the machine in place. A ball valve, spout and plug shall be provided to assist with draining oil with the machine in place.  Alternatively, speed reduction and synchronisation of shafts may be by double sided toothed belt with rotors indexed by a special tool to hold the rotors in the correct position, before being locked onto the drive shafts. Rotors may be locked onto the drive shaft by taper lock collet or a centre hub and high tensile machine screw with sealing cap. Minimum service factor through drive train shall be 2.0 based on design duty conditions. |  |  |
| Pump and rotor shaft arrangement | Replaceable elastomer internal sealing liner and hardened stainless steel rotors, or adjustable hardened stainless steel sealing plates with elastomer covered rotors. Interfaces between steel and elastomer shall be fully vulcanised. |  |  |
| Rotor shafts | One-piece construction with a minimum service factor of 2.0 based upon the maximum (pull-out) motor torque when started direct-on-line under maximum backpressure conditions. |  |  |
| Rotor shaft bearings | Include bearings within the pump (excluding motor bearings) selected for a LH10 service life of 100,000 hours in continuous pump operation at maximum rated conditions (calculated in accordance with AS 2729/ISO 281). |  |  |
| Mounting | A single, rigid mounting frame to support pump and gear motor/drive as a single rigid assembly. Motors shall be positively located, concentric flange mount motors for easy replacement and alignment. |  |  |
| Motor rating | Drives shall be rated for not less than 120% of maximum required design power, allowing for losses and inefficiencies within the system. |  |  |
| Motor mount standard | IEC standard flange mount motors (adapter plates and couples shall be fitted between motor and gearbox, if necessary) |  |  |
| Rotor and pump body materials | The Design Engineer and the supplier shall review the application, the process fluid and the operating conditions and confirm the most suitable materials and rotor geometry. |  |  |
| Shaft seals | Balanced single SiC/SiC replaceable mechanical cartridge seals shall be considered as a minimum requirement where seals are lubricated by process fluid under positive pressure. Pumps operating at negative pressures shall have double seals with external lubrication supply reservoir. Seals shall provide 20,000 hour minimum service life.  Bearings and gear housings shall be protected from possible seal leakage by either an integrated drain or early detection of primary seal leakage. The supplier shall consider the intended process fluid and operating conditions and propose a higher specification seal if warranted. Upgrading of the seal to a higher specification shall be a simple replacement of an interchangeable part. |  |  |
| External protective coatings | Conforming to Section 0  Protective Coatings as a minimum. |  |  |
| Corrosion resistance | All internal wetted parts shall be manufactured from highly corrosion resistant materials or lined with corrosion resistant materials. The Contractor and the pump supplier shall provide evidence that the overall pump bearing frame and housing assembly can provide the required minimum 25 year service life with the required adjustment and replacement of wearing parts such as liners, bearings, seals and rotors. |  |  |
| Process pipework | The pipework to and from the pump shall include:  A rise, such that the pump will always have a minimum volume of liquid to lubricate and cool rotors on start-up;  1¾” BSP sockets with 25NB stainless steel grade 316 ball valve and industrial hose connector for flushing points and drains on both the suction and discharge pipework;  1” BSP sockets with 15NB stainless steel grade 316 ball valve for pressure gauge connections.  The suction and discharge rise pipe connections on the upstream and downstream ends shall be AS4087 PN16 Flanges. |  |  |
| Rotation direction | Rotary lobe pumps may be used for reversible service applications. It is envisaged that this will be achieved using native features of the VSD driving the motor. |  |  |
| Priming and dry running | The pumps shall be capable of self-priming without damage to the internal components. The pumps shall be capable of dry running, without damage, for extended periods of time, and be designed to cater for the surging associated with intermittent wet and dry operation. The pump drive motors shall be capable of and be rated for accepting the shock loading associated with these conditions |  |  |
| Replacement parts | Key parts, including replacement rotors, wear plates, shaft sleeves, liners and couplings, mechanical seals, bearings and motors shall be readily available in Australia. |  |  |
| Shaft seals | Balanced single SiC/SiC replaceable mechanical cartridge seals shall be considered as a minimum requirement where seals are lubricated by process fluid under positive pressure. Pumps operating at negative pressures shall have double seals with external lubrication supply reservoir. Seals shall provide 20,000 hour minimum service life.  Bearings and gear housings shall be protected from possible seal leakage by either an integrated drain or early detection of primary seal leakage. The supplier shall consider the intended process fluid and operating conditions and propose a higher specification seal if warranted. Upgrading of the seal to a higher specification shall be a simple replacement of an interchangeable part. |  |  |

## Booster Pump Sets

### General Description

Water booster pump stations (typically for service/wash water duties) shall be a manifold set of same model pumps, each with its own variable speed drives. Pumps may be controlled by a single multi-pump variable speed controller or alternatively the system may work as a network of variable speed pumps such that the master control/coordination of the multi-pump set can be by any of the microprocessors controlling the VSD on the individual pumps on the manifold. The pumps shall be controlled to stop and start and change speed to maintain the discharge set-point pressure as flow from the system varies. Water booster pump stations shall include an electromagnetic flowmeter, with all pumps and instruments integrated into the SCADA system for trending. Water booster pump sets shall be housed within a building.

Water booster pump sets shall comply with the following requirements:

| Item | Requirement |
| --- | --- |
| Manifold | Pipework shall be stainless steel grade 316L to ASTM A312M  Connections shall be provided on the manifolds for air release, pressure gauges and pressure transmitters. Air release connections shall be 1¾” BSP sockets with 25NB ball valves. Pressure gauge and instrument connections shall be 1” BSP sockets with 15NB stainless steel grade 316 ball valves. |
| Pump redundancy | During peak flows, the system shall run as duty/standby configuration (N+1).  Each pump shall be capable of being removed without disturbing the other pumps and while the other pumps in the skid remain in service. |
| Flange connections | Flanges shall be to AS 4087 PN16 (clearly stamped). The supplier shall provide details of pump nozzle connections. |
| Isolation valves | Each pump on the manifold pump skid shall have its own suction and discharge isolation valves. Pump isolation valves shall be concentric, bed grooved, seal in body, tapped lugged butterfly valves conforming to AS 4795. Valves shall be supplied with lockable double action lever handles (Ebro Armaturen Z014-A or approved equal product). |
| Non-return valves | Each pump on the manifold pump skid shall have its own non-return valve. Non-return valves shall be wafer, flanged or lugged, and shall be disc or dual check type. Materials of construction shall be as follows:  Seat: EPDM  Disc: Stainless steel grade 316  Shaft: Stainless steel grade 316 or 420  Return spring: Stainless steel grade 316 |
| Pump skid mounting frame | The pump skid shall have a steel frame to provide a rigid base for the pump bases to be bolted down to and to rigidly locate the manifold pipes relative to the pump mounting base plate. The pump skid mounting frame shall be hot dipped galvanised to achieve 600 g/m² coating in accordance with AS/NZS 4680. |
| Pressure vessel | The pump station shall be supplied with a bladder type pressure storage tank sized to ensure effective operation of the booster set under all operating conditions, including delivery of low flows without excessive pump starts and stops, and smooth transition of flows across the full range. |
| Pump performance | The head-flow performance curve of the individual pumps on the pump skid shall have a steady rise from maximum to the minimum flow. The shut-off head value shall be a minimum of 20% higher than the head at the best efficiency point. |
| Pump materials | Materials of construction shall be as follows:  Pump base: Stainless steel grade CF8M.  Impellers, diffusers and stage rings: Stainless steel grade 316  Shaft: Stainless steel grade 431  Shaft journals and stage bearings: Silicon Carbide/Silicon Carbide  O rings: EPDM |
| Seals | Pumps shall be fitted with SiC/SiC cartridge seals with stainless steel grade 316 springs, EPDM bellows and O-rings as a minimum. The Design Engineer and the supplier shall review the operating conditions and provide a higher spec seal if needed. |
| Pump features | Each pump shall be fitted with a valved air bleed port at the top of its casing. |

# Gearboxes

Each gearbox shall be designed to operate continuously at maximum duty with a minimum service factor in accordance with AGMA (American Gear Manufacturers Association) based on maximum operating torque. In addition, each gearbox shall be designed to withstand starting torques of up to 250% of the full load running torque of the driving motor.

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

The direction of rotation of input and output shaft permanently marked on the housing. Removable gasketed inspection covers shall be provided to permit inspection of the gears without disassembly of the gear reducer. Lifting lugs shall be provided to facilitate safe lifting of the gearbox.

The gears shall be splash lubricated from a sump. The bearings shall be either splash lubricated or grease lubricated. Where grease lubricated bearings are fitted, seals shall be installed to retain the grease in the housing. Grease nipples and grease relief devices shall be fitted to housings containing grease-lubricated bearings.

The unit shall be provided with sight glass or indicator to observe oil levels. All oil fill and drain lines shall be of sufficient size to permit efficient functioning and shall be located on the gear unit in a position, which is easily accessible from the floor. The Contractor shall supply all oil and drain piping so that a container may be placed under the drain discharge.

# Drives and Couplings

## Couplings

The pumps and equipment (except submersible mixers and pumps) shall be fitted with flexible couplings (or vee-belt or wedge or toothed belt drives). Flexible couplings shall be of the cone-ring or flexible element type, rated to suit the torque output under all loading conditions.

Care shall be taken in checking alignment of driving and driven shafts. The motor and driven equipment shall be in alignment from all aspects.

Pulleys and couplings should be balanced before the keyway is cut to eliminate vibration caused by lack of balancing. Then the whole assemblies complete with key shall be finely balanced after assembly.

## Vee Belts, Wedge Belts and Toothed Belts Drives

Vee-belt wedge-belt drives shall comply with AS 2784 (Endless Wedge belt and V belt drives). All drives shall be designed with a minimum service factor of 2 based on motor rated power. Belts shall be standard commercial items readily available locally and normally kept in stock. Pulleys and sprockets shall be keyed onto the shafts using a taper type locking bush.

The belt manufacturer's recommendations for installation and alignment shall be strictly adhered to when fitting belt drives.

## Chain Drives

Chains shall be standard roller chains comprising steel links hardened steel pins and rollers. Chains shall comply with AS 1532 "Short pitch transmission precision roller chains and chain wheels" and shall have a minimum pitch of 19 mm. Sprockets shall be of steel with flame hardened teeth, with hardness not less than 360 Brinell. Access covers for inspection and lubrication of the chains and sprockets shall be provided in an easily accessible location.

# Mixer Requirements

## General Requirements

Mixers shall:

1. Be submersible type, however, in cases where the design of the facility incorporates platforms or it is advantageous to the Principal to do so, then vertical shaft mixers shall also be acceptable
2. Be of non-ragging, propeller type suitable to operate in a sewage environment;
3. Be designed and configured to prevent build-up of rags and roping of fibres;
4. be guaranteed to operate continuously at all depths greater than the minimum submergence level without:

* Formation of vortices;
* Entrainment of air into the liquid;
* Surface splashing or substantial surface disturbance;
* Voiding of inflow to the propeller; and
* Over-heating of the motor;

1. Be current models which have been in successful and proven operation under comparable conditions for at least two (2) years;
2. Be clearly and permanently marked with the direction of rotation in the frame;
3. Include a mixer support system which provides ease of removal and the flexibility to adjust the mixer angle horizontally and vertically in order to produce the required thrust to maintain adequate mixing; and
4. Be selected to maximise operating efficiencies without modification of the propeller, and to maximize the hydraulic power transmitted to the fluid.

Power consumption of the mixer at operating speed shall not exceed 95% of the available motor rated power output at that speed.

Materials of construction, including all guides and lifting equipment, shall be stainless steel grade 316.

The Contractor’s Design Engineer shall be responsible for the selection of mixer to achieve the process mixing requirements for all depth and fluid throughput scenarios. Unless stated otherwise in the Project Requirements Document, this shall be taken to be optimum mixing for the processes in the tank, prevention of deposition of solids throughout the entire tank or process cell, eliminate short circuiting or dead/unmixed areas within the process cell or tank.

## Propeller Mixers

### Sewerage Service Environment

The Contractor’s Design Engineer must not rely on the effectiveness of upstream screenings removal equipment when selecting propeller mixers. Propeller mixers must be able to handle service in unscreened sewage regardless of the intended service location within the process.

Unscreened sewage shall be deemed to include:

1. Frangible solids;
2. Hard solids, e.g. grit, sand and stones;
3. Fibrous solids, e.g. rags, rope and sanitary napkins, hair; and
4. Mineral and other oils.

## Propellor

The propeller shall:

1. Be of the non-clogging, non-ragging backward curved leading edge type;
2. Be impact resistant;
3. Be cast from stainless steel grade H6C in compliance with AS2074, accurately finished to reduce friction losses to a minimum;
4. Be dynamically balanced prior to assembly in accordance with AS3709 grade G6.3; and
5. Have a maximum tip velocity not exceeding 16 m/s.

## Drive Shafts

The drive shafts shall be machined from one piece solid bar stock of stainless steel grade 316, with hardened sleeve, or grade 431 or other suitable high strength, corrosion resistant steel alloy and have a ground finish over the entire length.

## Shaft Seal and Seal Chamber

Sealing of the propeller shaft onto the motor shaft shall be by two bi-directional independent mechanical seals, contained within an oil bath in a seal chamber. Each mechanical seal shall:

1. Be of robust construction, designed to withstand the adverse operating conditions associated with sewage;
2. Be guaranteed for a minimum operating life of 40,000 hours under normal sewage operating conditions;
3. Utilise seal face materials manufactured from either silicon carbide or tungsten carbide; and
4. Utilise a replaceable cover housing with lip seals, manufactured from Viton with non-corroding springs to protect the outer moving parts of the mechanical seal from sludge, grit and fibre.

The seal chamber shall incorporate oil fill and drain points and a leakage detection device in order that water leakage past the primary seal is detected and an alarm signal generated.

Pressure compensation shall be provided for the oil in the seal chamber.

All revolving parts shall be balanced both statically and dynamically so that when running at full normal speeds and at the most arduous loading conditions there shall be no undue vibration.

## Bolting and Fasteners

All bolts and fasteners external to the mixer shall be manufactured from stainless steel grade 316. Holding down bolts shall be stainless steel grade 316. Metal free anti-seize grease/compound shall be used during assembly.

## Motor Housing

The motor housing shall:

1. Be of stainless steel grade 316 construction or better;
2. Be designed to withstand submergence to a depth of 20 m head without leakage;
3. Incorporate cable entry glands; and
4. Facilitate cooling of the motor.

## Motor Cooling

The motor shall be designed and adequately rated to operate in the specified fluid at temperatures of up to 32 °C.

## Motor Protection

The motor shall be protected from overheating by:

1. PTC thermistors or alternative thermal sensor system (details to be provided, and subject to Principal acceptance) - a minimum of one (1) embedded in each of the three (3) stator windings (5 kW and above); and
2. A moisture detection device fitted inside the primary seal to provide early detection of primary seal or cable gland leakage, and the cable termination housing.

## Cables and Motor Entry Glands

Cables shall be multi-core flexible neoprene sheathed, suitable for immersion in the specified fluid.

Cables incorporating cores for power, stator thermal protection and moisture detection shall have the protection and detection cores provided within secondary sheaths.

All cables entering the motor shall be glanded to a single demountable flange. The length of electrical cable required for each motor shall be not less than 10 m.

Cables shall be supported by the lifting davit support structure and restrained from excessive movement. All clips, shackles, etc. shall be fabricated from stainless steel grade 316. Mechanical protection of the cable sheath shall be provided as required.

## Placement and Removal Equipment

The mixer shall be supplied complete with a placement/removal system incorporating:

1. Mixer guide rail and rail support brackets;
2. Lifting davit, complete with hand winch; and
3. Lifting wire and cable capture clips.
4. The mixer guide rail arrangement shall:
5. Be designed such that the mixer can be placed and removed without bolting of joints, or use of tools;
6. Permit adjustment of the mixer orientation in the vertical and horizontal planes;
7. Comprise a single continuous rail extending from the base of the tank to the level of the maintenance access platform;
8. Be capable of withstanding the loads imposed during operation, placement or removal of the mixer, to ensure that the mixer can be raised and lowered without lateral deviation;
9. Permit accurate location of the mixer; and
10. Ensure that there is no interference of the guide arrangement on other static structures.

All components of the mixer guide rail shall be manufactured from stainless steel grade 316 or 316L.

The lifting davit shall:

Be dedicated to a single mixer;

Be separate from the guide rail and attached to the concrete walkway/wall;

Be of a substantial construction and load rated for lifting at least 1.5 times the mixer weight without undue deflection;

Permit raising and lowering of the mixer without staging of the operation;

Traverse from the maintenance platform onto the guide rails without jib extension;

Include a bearing to permit free and easy rotation of the davit allowing the mixer to be moved from the maintenance platform to the guide rails and vice a versa;

Include a stainless steel hand winch incorporating a ratchet and friction lock;

Be galvanically isolated from the maintenance platform and handrails; and

Comply with the requirements of AS/NZS 1418.

The davit arrangement shall permit easy removal of the mixer by one operator. Sufficient radius and turning arms shall be provided to enable the loaded davit to be easily turned from the tank onto the walkway/maintenance access platform.

Where direct mixer loading/unloading from a standard crane truck is not practical, the access walkway to each mixer location shall be wide enough and otherwise designed to accommodate a trolley for transfer of the mixer to a suitable point for loading to/from a crane truck.

Where safe handling requires the use of a trolley for mixer relocation, installation or removal, the Contractor shall provide a suitably configured trolley.

The lifting wire shall:

Be a continuous length of 316 stainless steel twisted wire cable installed, saturated with a suitable lubrication and water exclusion barrier product, in accordance with cable manufacturer’s requirements;

Be rated for the anticipated loads (including screenings) to the manufacturer’s recommended service factor;

Be designed for a minimum service life of five (5) years within the system;

Include stainless steel grade 316 shackles, connection(s), clips etc. to the mixer; and

Include break-type clips for attachment of the motor cable(s).

All structural and load bearing components associated with the davit shall be manufactured from stainless steel grade 316L. All fasteners shall be manufactured from stainless steel grade 316 (A4.7 installed with metal free anti-seize compound).

Surfaces of components subject to rubbing or sliding action shall be provided with elastomeric bushes, pads, etc. designed to prevent corrosion and surface damage to the stainless steel.

Dynamically loaded components shall be one piece castings.