TWEED SHIRE COUNCIL

MECHANICAL DESIGN SPECIFICATION

ME02

PUMPS

TABLE OF CONTENTS

ABBREVIATIONS

ABBREVIATION	INTERPRETATION
AOP	Allowable Operating Pressure
AS/NZS	Australian / New Zealand Standard
DA	Development Approval
DN	Nominal Diameter
KL	Kilolitre
KPA	Kilopascal
KW	Kilowatt
L/S	Litres per second
MAOP	Maximum Allowable Operating Pressure
MPA	Megapascal
NPSHA	Net Positive Suction Head Available
NPSHR	Net Positive Suction Head Required
P&ID	Process and Instrumentation Diagram
PN	Nominal Pressure Class
SS	Stainless Steel
WSAA	Water Services Association of Australia
WS-SPEC	Water Services Specification
WWSS	Wastewater Swirl Separator

1 CITATION

This document is named "Tweed Shire Council, Mechanical Design Specification ME02 - Pumps".

This document has the following functions:

- To relate to and comply with Tweed Shire Council's Land Development Specifications D11, D12, C401 and C402.
- To nominate the Water Services Association of Australia (WSAA) Codes and associated documents as the general requirements to be met for the Asset Creation process within the Tweed Shire Council Area of jurisdiction.
- To specify parameters, requirements and functions contained within the Codes that Principal is to nominate or to amend.
- To specify additional technical and/or administrative matters (that are not otherwise specified within Australian Codes or Standards) pertaining to NSW Government Department of Planning.
- To specify any technical requirements not covered by the Codes.
- To identify materials, solutions and methods permitted by the Codes that is not acceptable to Principal.
- To specify preferred options where the Codes provide for several methods to deal with a particular issue.

This document, as a Specification, is based upon compliance with the Sewerage Code of Australia (WSA-02), Water Supply Code of Australia (WSA-03), the Sewage Pumping Station Code of Australia (WSA-04), Vacuum Sewerage Code (WSA 06) and Pressure Sewerage Code of Australia (WSA 07)) and is complimented by the strategic product specifications and technical requirements contained within WS-SPEC National Water Industry Specifications.

WSA-02, WSA-03, WSA-04, WSA-06 and WSA-07 are available from the Water Supply Association of Australia (WSAA), email: info@wsaa.asn.au,

WS-SPEC and Australian Standards are available from the Saiglobal webshop at www.saiglobal.com/shop.

For all design and construction contracts, all alternatives to these specifications will require specific approval of Tweed Shire Council.

2 ORIGIN OF DOCUMENT, COPYRIGHT

3 VERSIONS

VERSION	AMENDMENT DETAILS	CLAUSES AMENDED	DATE ISSUED (The new version takes effect from this date)	Authorised by the Director of Engineering Services
1.1	Draft for review		10-Sept-2007	
1.2	Draft with Upgrades	All	18-Aug-2008	

4 DEFINITIONS

In this document:

"**Standard"** shall mean and include a Standard Specification, Standard Code of Practice or other Standard issued by a recognised association or body set up for the purpose.

"Australian Standard" or the abbreviation "AS" shall mean a Standard issued by the Standards Association of Australia.

"Draft Report" or the abbreviation "DR" shall mean a draft of an Australian Standard issued by the Standards Association of Australia.

"British Standard" or the abbreviation "BS" shall mean a Standard issued by the British Standards Association.

"International Standard" or the abbreviation "ISO" shall mean a Standard issued by the International Standards Organisation.

"Principal " – The Principal is as defined in GC21 and is Tweed Shire Council.

"Principals' Authorised Person" - is as defined is GC21

"Contractor" denotes the person or corporation bound to execute construction and related work on behalf of the Principal.

"Designer" means a company, consultant or Professional Engineer who is qualified and is competent to perform the engineering works required for the Asset Creation process on behalf of a Developer.

"The Code" means the Water Services Association Codes (Sewerage Code of Australia (WSA-02) and the Sewage Pumping Station Code of Australia (WSA-04) and Water Supply Code of Australia (WSA-03), Vacuum Sewerage Code (WSA 06) and Pressure Sewerage Code of Australia (WSA 07))

"WS-SPEC" means the national standard water industry specifications.

5 SCOPE

The intent of this Standard Specification is to provide a means of ensuring a uniform approach to and standardisation of the design and installation of mechanical pumping equipment.

All Works specified within this document shall be a minimum requirement.

5.1 Inclusions

The scope of work includes the design, supply, factory testing, delivery to site, installation, site testing and commissioning of the pumps. In addition, the scope of work shall include but not be limited to the following.

- Design of equipment including provision of design calculations and drawings.
- All support plates and holding down bolts necessary for the secure installation of the pump and motor set.
- Rectification of defects during the defects liability period.
- All wiring, fixings and supports for any electrical installation integral to the equipment.
- All internal piping.
- All holding bolts and fixings.

- Preparation and supply of 3 hard copies and 3 electronic copy of operating and maintenance manuals.
- Supply of detailed installation and works as executed (WAE) drawings, installation instructions and commissioning procedures.
- Spare parts and tools.
- Special screen/shielded cables are required for all pumps greater than 22.5 kW or having a Variable Speed Drive (VSD). Lengths of cables shall be confirmed with the Principal's Authorised Person before ordering.

5.2 Reference Documentation

The documents listed below form part of this specification. They are listed in order of precedence.

Items marked with '*' are provided with this specification.

- Tweed Shire Council land Development Specifications D11, D12, C401 and C402
- This document *
- Equipment Schedules (Datasheets) *
- General Mechanical Specification ME-01 *
- Water Services Association Codes (Sewerage Code of Australia (WSA-02) and the Sewage Pumping Station Code of Australia (WSA-04) and Water Supply Code of Australia (WSA-03))
- WS-SPEC
- Relevant Australian Standards
- Relevant International Standards

6 STANDARDS

The Principal shall possess, or have access to; the latest edition of all documents required to comply with this Specification, including all current amendments and supplements of those documents. The Principal shall include all relevant specifications and requirements of these documents into the design of the works.

a) Council Land Development Specifications

Development Design Specification – D11 Water Supply

Development Design Specification – D12 Sewerage System

Development Construction Specification – C401 Water Reticulation

Development Construction Specification – C402 Sewerage System

b) WSAA Codes of Practice,

WSA-02 – Sewerage Code of Australia

WSA-04 - Sewage Pumping Station Code of Australia

WSA -03 – Water Supply Code of Australia

c) WS-SPEC Water Services Specification,

d) Australian Standards

References in this Specification or the Drawings to Australian Standards are noted by their prefix AS or AS/NZS

The Designer shall use the latest edition of all relevant Australian Standards, including all current amendments, supplements and replacements applicable thereto.

Australian Standards are listed within WSA-02, WSA-04 and WSA-03.

Pumps and all materials and equipment used in their construction shall be new and in accordance with the following Australian Standards.

AS1111.1	ISO metric hexagon bolts and screws - Product grade C - Bolts
AS1111.2	ISO metric hexagon bolts and screws - Product grade C - Screws
AS1565	Copper and copper alloys - Ingots and castings
AS1646.1	Elastomeric seals for waterworks purposes - General requirements
AS1830	Grey cast iron
AS1831	Ductile cast iron
AS2074	Cast steels
AS2417	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1 and 2
AS4087	Metallic flanges for waterworks purposes
AS2129	Flanges for Pipes, Valves and Fittings
AS4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A480	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
BS 4641	Method for specifying electroplated coatings of chromium for engineering purposes
BS 4506	Specification for shaft ends
BS 3170	Specification for flexible couplings for power transmission
BS EN 953	Safety Of Machinery - Guards - General Requirements For The Design And Construction Of Fixed And Movable Guards
ISO 10882-1	Safety Of Machinery - Interlocking Devices Associated With Guards - Principles For Design And Selection
ISO 12100-1	Safety Of Machinery - Basic Concepts, General Principles For Design - Part 1: Basic Terminology, Methodology

7 GENERAL

Reference shall be made to the pumping station section of the Tweed Shire Council land Development Specifications D11, D12, C401 and C402. Where are conflict exists between this specification and the Development Specifications the Development Specifications will take precedence.

The Designer shall take into account site access, site maintenance and restoration, easement requirements, power supply and construction lay down working areas when locating pumps.

7.1.1 Standby

Standby pumping capacity shall be provided such that if one pump is out of service, the pump station/system will remain able to supply the required transfer capacity.

7.1.2 Upgrades to Existing Pumps

The provisions of this specification for new pumping stations as detailed above shall also be applicable to the upgrade of any existing pumping stations that may be required to be undertaken as a result of the development works.

7.1.3 Pump Selection

Pump selection shall be consistent with the minimum whole-of-life (NPV) cost of the pumping station based on the calculated mean system curve. Each pump and its drive unit shall be suitable throughout the specified range of station requirements such as flow rates, heads and duty points.

Pumps shall be designed to meet the following requirements:

(a) To give prolonged running at the required output under site conditions.
(b) To have a stable ‘head-quantity’ characteristic and show sufficient rise from the duty point to closed valve to avoid large changes of output with small changes of head.
(c) To be suitable for use with a modified impeller that will give the required output against 110% of the specified head.
(d) The selected pump H-Q performance curve shall extend to intersect all system curves. The pump motor shall be rated for the maximum power required at the H-Q system curve intersection point.

Selection of the pumps shall be based on:

(a) system head for ultimate flow requirements;
(b) capable of operating near optimal efficiency within the range of operating conditions;
(c) continuous operation;
(d) having non-overloading characteristics beyond the duty point close to zero head;
(e) having starting characteristics acceptable to the electricity supply company and the ‘s;
(f) having a minimum of 4 pole unless approved otherwise by Principal’s Authorised Person.

7.1.4 Information Required with Tenders

A dimensioned general arrangement drawing of the pumpset shall be provided with the Tender. This shall indicate, where appropriate, the minimum clearance distance required for the removal of components (for refurbishment or replacement) with the pumpset in situ.

8 GENERAL PUMP REQUIREMENTS

The Contractor shall select the pumps after designing the pumping layout and calculating all head losses in the piping system. All calculations and drawings shall be submitted before purchasing the pumps.

The pumps shall be designed and sized for the required duties, including all flow ranges, fluids (including contaminants), temperatures and pressures.

The Pumps shall comply with the following requirements:

(a) The Pumps shall provide the required mode operation within the designed operating range.

(b) NPSH Required by the pump must be a minimum of 1 m less than the NPSH Available, or a minimum of 10% less than the NPSH Available (whichever figure is greater), at all points between minimum continuous stable flowrate and the pump rated duty point,

(c) The Contractor shall select the pump with high efficiency and with a less-than-maximum–diameter impeller so that modest increases in flow can be obtained by changing to a larger impeller. For VSD pumpsets, pumps shall have the maximum diameter impeller installed , but must be capable of at least 5% increase in head from rated with an allowable increase in speed.

(d) The Contractor shall design the suction piping conservatively so that larger pumps can be substituted.

(e) The required design capacity, including the maximum, normal, and minimum flows to be pumped, shall be considered when selecting the type and size of pumping equipment.

(f) The Pumps shall provide the required turndown and be capable of pumping over the complete design flow range.

(g) Wherever possible the Contractor shall choose larger, lower-speed pumps which are resistant to abrasive wear. The maximum pump speed for sewage pumps shall not exceed 1450 rpm.

(h) The maximum pump speed for progressive cavity pump for sludge pumping shall not exceed 300rpm,

(i) Suction specific speed for the pump shall not exceed 627 m/s,

(j) The pump shall be selected to operate at high efficiency with the specified duty point as close as possible to the best efficiency point (BEP) of the pump. Preference will be given to pumps operating between 80 and 100% of BEP flowrate.The efficiency curve of the pumps shall be reasonably flat over the operating range for normal conditions, with maximum efficiency developed when pumping at average conditions.

(k) The whole unit shall be resistant to the corrosion associated with sewage treatment plant.

(l) The Contractor shall guarantee and substantiate that the performance of the pumping units, shall be in accordance with the pump curves submitted, within a tolerance of plus or minus 2.5% to comply with AS 2417 “Pumps –International acceptance codes”.

(m) All pump casings and discharge connection shall withstand hydrostatic pressure equal to 2.5 times the allowable operating pressure

(n) Impellers, balance drums and similar major rotating components, shall be dynamically balanced to grade G6.3 of ISO 1940. Rotating elements of multi-stage pumps shall be balanced to a grade of G2.5 of ISO 1940,

(o) Overall sound power level shall not exceed 85 dBA when measured at 1 m from the equipment.

All pumps shall be manifolded in such a way that they can be easily be isolated, removed and replaced by a spare pump during plant operation and without disturbance to the pipework upstream of the suction isolating valve and downstream of the delivery valve.

Pumps Flanges shall comply with the requirement of AS 4087 "Metallic Flanges for water works purposes" or AS 2129 “Flanges for pipes, valves and fittings”. Holes shall be off centre. Use of special adapter flange shall be subject to the approval of Principal’s Authorised Person.

8.1 Process information

8.1.1 Operating environment

The operating environment of the pumpset (including details of hazardous areas, etc.) shall be as specified in the Schedule.

Unless otherwise specified in the Schedule, the pumpset shall be capable of satisfactory operation within the ambient air temperature range -10° C to + 50 °C and up to a relative humidity of 100 %.

Any special hazards associated with the operating environment shall be as specified in the Schedule.

Any references for any further information relating to the operating environment or site not transferable via the Schedule (e.g. drawings of site layouts, pipework installations etc.) shall be as specified in the Schedule.

8.1.2 Process fluid

The type and properties of the pumped medium shall be as specified in the Schedule.

The maximum diameter of solid sphere required to be passed by the pumpset shall be as specified in the Schedule.

8.2 Performance specification

8.2.1 General

All heads shall be relative to the centreline of the impeller.

The pumpset asset life shall be as specified in the Schedule.

The maximum operating speed of the pumpset shall be 1500rpm, unless specified otherwise or approval is given by the Principal’s Authorised Person to use two-pole motors.

8.2.2 Hydraulic Performance

The pumpset hydraulic performance, efficiency and absorbed INPUT power shall be as specified in the Schedule.

The flowrate at the guaranteed duty point at operating speed shall be between 50% and 110% of the best efficiency point.

8.2.3 NPSH

The pump shall be selected to have a Net Positive Suction Head Required (NPSHR) that is not in excess of 10 metres head at any point between zero flow and 120% of the maximum operating flow. The NPSHR shall be taken as the drop in suction head that results in a pump discharge head drop of 3% under a test with variable suction head, constant operating speed and constant discharge conditions. The pump shall be selected such that the Net Positive Suction Head Available (NPSHA) always exceeds the NPSHR by atleast 1 m at all potential operating points. At the maximum flowrate at the operating speed, the margin of NPSHA above NPSHR for continuous operation shall be determined so as not to cause excessive pump noise, vibration, or damage due to cavitation.

8.2.4 Testing

Pumps shall be tested in accordance with AS2147.

The Contractor shall guarantee and substantiate that the performance of the pumping units, shall be in accordance with the pump curves submitted, within a tolerance of plus or minus 2.5% to comply with AS2147.

All pump casings and discharge connection shall withstand hydrostatic pressure equal to 2.5 times the allowable operating pressure. (With a minimum of 1600kpa unless otherwise specified).

The contractor shall submit a copy to Principal's Authorised Person of all tests conducted on the pump.

8.3 Design Specification

8.3.1 General Requirements (all pump types))

8.3.1.1 Materials Selection

Unless specified otherwise in the Specification, the quality of materials used in the construction of the pump shall be in accordance with the WSA-04 (WSA Pumping Station Code of Australia) and WSA-03(Water Supply Code of Australia) documents.

Materials shall be selected with proper reference to the specified operating environment, pumped liquid, guaranteed/expected service life and availability.

Materials to be used in the pump station shall take into consideration the nature and composition of the fluid to be pumped. The designer shall select such materials to ensure durability for a nominal design life of at least 50 years.

Where surfaces (such as stainless steel wear rings) may be subject to galling, materials shall be selected to minimise wear and have a minimum hardness differential of 50 HB.

8.3.1.2 Impeller

The impeller type shall be as specified in the Schedule.

The impeller shall be of a modern design and ample thickness and strength for the duty involved, with high efficiency and non-clogging properties.

The type of impeller shall be selected to prevent fouling, allow the passage of fibrous and solid materials and to suit the operating conditions.

The impeller shall be a one piece casting.

The impeller shall be secured to the pump shaft by a suitable method to prevent it becoming loose or fall off the shaft under any possible operating conditions including reversed rotation. The

impeller shall not be pinned to the shaft, nor shall shaft rotation be relied upon to ensure that the impeller is locked in position.

The impeller shall have a minimum number of vanes compatible with satisfactory balancing, having regard to the specified minimum sphere passed or other equivalent criteria used by pump manufacturers.

With the exception of single vane impellers, the impeller shall be dynamically balanced in two planes to prevent the pumpset exceeding the maximum vibration levels specified. Balancing shall be achieved by machining, not by addition of weights.

The impeller shall be fitted with a replaceable inlet wear ring. Impeller wear rings shall be fixed in place by the method specified in the Schedule. The wear ring material(s) shall be as specified in the Schedule.

The direction of rotation of the impeller(s) (viewed from the non-drive end) shall be as stated in the Schedule.

All pumps components shall be capable of withstanding without damage the effects of accidental reverse rotation due to reverse flow through the pump up to 120% of normal direction rated speed.

8.3.1.3 Pump motors

Pump motor must not operate faster than 1500 rpm.

Refer to Tweed Electrical Specification *EL07 - Electric Motors and EL19-Wastewater Pump Stations.*. Where VSD drives are to be used, refer to the requirements of the Tweed Shire Standard Electrical Specification for Variable Speed Drives-EL09.

Unless specified electric motor shall be sized based on the maximum power requirement for the selected diameter impeller (i.e motor shall be non-overloading over the entire curve from shutoff to end of curve).

As a minimum, motors shall have IP56 protection for dry situation and IP66 for use when submerged.

8.3.1.4 Pump Critical Speed

The shaft shall be of rigid construction and designed such that the first lateral critical speed is at least 150% higher than the maximum operating speed of the pump.

The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wear rings.

The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads. Support by the mechanical seals shall not be considered when determining shaft deflection but allowance may be made for the hydrodynamic bearing effect or running clearance.

8.3.1.5 Shaft

The common pump/motor shaft shall be of a robust construction to withstand maximum stresses and vibrations under all operating conditions.

The shaft assembly shall be such as to preclude entry of water to the bearing housing.

The shaft and the motor rotor shall be dynamically balanced as an integral assembly.

The shaft shall have a ground finish over its entire length.

The maximum shaft deflection should not exceed 0.05 mm at the location of the mechanical seal faces when operating at duty flowrate and 0.1 mm at minimum continuous flow rate.

For pumps with impeller diameter 178 mm or less pump shaft stiffness ratio shall be less than 3 (metric units). For pumps with impeller diameter greater than 178 mm, shaft stiffness ratio shall be less than 2.4 (metric units).

Wherever the shaft passes through a bearing housing, seals shall be provided to prevent the ingress of dust and moisture.

Seals shall be provided to prevent leakage of the pumped liquid between the shaft and sleeve.

8.3.1.6 Shaft seals

Pumps shall be supplied with “large bore” seal chambers suitable for a modern mechanical seal design (i.e not a long narrow stuffing box designed for gland packing). Vendor shall provide dimensions of seal chamber with bid.

Sealing between the casing and the volute shall be achieved by primary (casing volute to oil chamber) and secondary (oil chamber to motor enclosure) mechanical seals and by an oil filled chamber between the primary and secondary seals.

The seals shall effectively and reliably prevent the ingress of the pumped liquid into the bearings or the motor.

The seals shall be of the balanced type, cartridge mounted, incorporating bellows or multiple helical springs of stainless steel grade 316 and high nitrile synthetic rubber or ethylene propylene static "O" rings.

Submersible type pumps shall be fitted with seal failure probes for moisture and oil leakage. The probe shall be fitted in the oil bath between the two mechanical seals and shall be arranged to detect the presence of water in the oil bath. Alternatively pumps with a air cavity and float for detection are acceptable.

The seal type and manufacturer shall be as specified in the Schedule.

If flushing, cooling and/or lubrication is required to maintain seal performance, the method of flushing, cooling and/or lubrication shall be as stated in the Schedule. The flushing, cooling and/or lubrication requirements (pressure, flow rate and source) shall be as stated in the Schedule.

8.3.1.7 Pump bearings

Bearings and lubrication shall be in accordance Clause 17.

Unless specified otherwise in the Schedule, all pump bearings shall have a theoretical L_{10h} life of 26,000 hours at the guaranteed duty point (GDP). The actual bearing L_{10h} life at the GDP shall be as stated in the Schedule.

Bearing housings shall be designed to prevent the ingress of dust and water. Only mechanical seals permitted. The bearing housing material shall be as specified in the Schedule.

Following alignment of the rotating element in the casing, the bearing housing shall be doweled or spigoted to ensure accurate repositioning after maintenance.

For oil lubricated bearings, the bearing housing shall be designed so that the oil can be easily drained and replaced without spillage.

8.3.1.8 Coupling

The coupling type and manufacturer shall be as stated in the Schedule. Spacer type couplings shall be provided for applications where mechanical seals are fitted.

8.3.1.9 Baseplates

The support structure material shall be as stated in the Schedule.

The support structure shall be stiffened to prevent the pumpset producing excessive vibration. To meet manufacturers requirements

The support structure shall be locally reinforced around foundation bolt-holes.

The support structure shall be designed to be crevice free to prevent the collection of water and debris during operation. Baseplates shall be designed to prevent the formation of trapped air pockets during grouting.

Hollow sections are not to be use for base plates. Open sections are to be used and be oriented to allow water to drain away and not form pools.

Baseplates are to be hot dip galvanised after fabrication.

8.3.1.10 Guarding

Guarding shall comply with ISO 12100-1 and AS4024.1601-2006.

If access is required to components for process correction or maintenance, removable guards shall be provided.

Pumpset components that may require regular access for maintenance or condition monitoring (e.g. lubrication points and bearing vibration sensors shall be accessible without removing guards.

8.3.1.11 Nameplates

All pumps shall be fitted with engraved or embossed stainless steel nameplates fastened to the pump body. Nameplate information shall include as a minimum the manufacturer's name, address (or agent's address), model number, serial number, head at the Guaranteed Duty Point (GDP), flow rate at the GDP, operating speed, motor kW, full load current, equipment identification number, contract number and date of manufacture and pump casing test head. The nameplates shall be permanently attached to the pump using stainless steel fixings and be clearly visible after installation. The nameplate shall not be painted. A second duplicate plate is to be provided to the Principal's Authorised Person.

8.3.1.12 Pump weights and lifting arrangements

The weight of each major pumpset component and the heaviest individual maintenance and erection lifts shall be as stated in the Schedule.

Non-rotating components weighing over 25 kg shall incorporate clearly identified, permanent lifting points located to give a safe, balanced lift. If lifting points are not designed for lifting the whole pumpset, they shall be clearly marked accordingly.

8.3.1.13 Dismantling joints

The design shall provide for dismantling joints or bends in the pipework to facilitate removal of the pumps and valves for maintenance.

8.3.1.14 Surge analysis and control

The Designer shall undertake surge analysis as part of the pumping station design and shall provide surge control equipment as required by the analysis to maintain maximum transient operating pressures (positive and negative) within an allowable range, compatible with the design of the associated rising main.

8.3.1.15 Confined spaces

The Designer shall consult Principal's Authorised Person with respect to the provision of suitable arrangement for access into underground structures and statutory requirements for the entry of personnel into confined spaces.

9 TYPE AND APPLICATION

Type of pumps to be used shall be in accordance with the in Table below. Use of other type pumps shall be subject to the approval of the Principal's Authorised Person.

Pump Service	Type of pump	Features
Submersible raw sewage	Submersible centrifugal to comply WSAA /WSA101	High efficiency and impeller with non clogging properties capable of passing 76mm sphere
Screened sewage	Submersible centrifugal to comply WSAA /WSA101	High efficiency and non clogging properties
Grit slurry	Recessed vortex impeller, or torque flow	Casing and impellers shall be treated for abrasive and corrosive nature of grit slurry Warman torque flow or equivalent
	Air lift pump	Low wear low head applications. Does not need a pump chamber.
Mixed liquor	Centrifugal or mixed flow pump Submersible centrifugal to comply WSAA /WSA101	Impeller with non clogging properties
RAS	Centrifugal recessed impeller or mixed flow pump, Or Archimedes screw type	
Raw sludge, digested sludge with 1 to 3%	Centrifugal pump with recessed vortex impeller, mixed flow or screw type impeller (hydrostal or equivalent) Progressive cavity pump	Impeller with non clogging properties
Scum Pump	Centrifugal pump with recessed vortex impeller, mixed flow or screw type impeller (hydrostal or equivalent)	Arrangement for full mixing or other measures to prevent build up of scum
Thickened sludge or digested sludge 3% to 7%	Progressive cavity or rotary lobe.	Maximum speed shall not exceed 300rpm
Thickened sludge greater than 7%	Positive displacement piston pump	Specialist design.
Reclaimed effluent	Centrifugal or turbine pumps	Flygt, Grundfos or equivalent

Pump Service	Type of pump	Features
Polymer dosing pumps	Progressive cavity	
Chemical dosing pumps	Positive Displacement.	
Clean/Potable Water	End Suction Centrifugal/Split Axial	

10 SUBMERSIBLE (CENTRIFUGAL)

10.1 General

The principal's preferred pumps for submersible water and sewage service are either:

ITT FLYGT "N" Series, or

GRUNDFOS SARLIN

Other pumps may be considered with Principal's Authorised Person's Approval.

Pump shall be capable of operating at the required duty point for the application. Pump shall be

(a) capable of operating near optimal efficiency within the range of operating conditions;
(b) continuous operation;
(c) having non-overloading characteristics beyond the duty point close to zero head;
(d) having starting characteristics acceptable to the electricity supply company and the Principal.

Package pump station units may be used with the prior concurrence of Principal's Authorised Person, where the area being serviced is small and/or their inclusion contributes to overall benefits to the system and the environment.

Each submersible pump shall be checked for the operation against a closed discharge (shut-off head) to prove the effectiveness of the seal between the pump and the discharge bend.

When two or more similar pumps are supplied under the same Contract, the inter-changeability of the units and the discharge bends shall also be checked.

10.2 Installation

10.2.1 Wet -Well

The design of the wet well submersible pumping unit shall be such that the complete pumping unit can be readily removed from the wet well by means of a lifting device or mobile crane, without the necessity of either de-watering the wet well or disturbing the permanent connection to the discharge pipe work, and without the need to descend into the wet well.

No portion of the pump shall be permanently fixed to the base of the wet well. The wet well units shall be supported off the discharge 'duck-foot' bend which shall be of a rigid design to take the complete pumping unit load and provide sufficient sealing.

The pump shall have suitable guide rails for withdrawal from and lowering into the wet well. When lowered down the guide rails the pump shall automatically connect to the discharge bend.

10.2.2 Dry Well Installation

The dry well units shall be supplied with a suitably sized baseplate or stool and a fabricated structural steel supporting frame for vertical installation. The stool or baseplate and the supporting frame shall be designed to suit the pump suction arrangement. The pump suction or suction bend is to be a flanged connection. Access to the pump suction or suction bend shall be as close to the bend as practical and is to be provided. Design shall be so that no work below the stool/baseplate is needed when installing or removing the unit.

10.3 Motor Cooling

The contractor shall warrant that motor cooling by means of pumped media circulation is suitable for the specific application.

The pumped medium shall cool the motors so no external cooling is required. Larger and dry well installed motors shall be provided with a cooling jacket with continuous circulation of a portion of the pumped liquid.

10.4 Flush Valve

Where specified, the wet well submersible pumping units shall be fitted with an automatic flush valve. The valve shall open at each pump start for approximately 30 seconds to stir up the sludge settled in the wet well. Preferable, the valve opening/closing operation shall be induced by the pump flow and pressure, thus eliminating the need for electrical components and cable.

11 CENTRIFUGAL PUMPS

11.1 General Requirements

The pump casing and impeller shall be fitted with a replacement inlet wear ring. The wear ring shall be constructed so that it can be easily replaced when necessary.

Pumps shall be **End Suction Centrifugal or Split Casing Axial type**. All end suction pumps shall be arranged for back pull out. If either of these pump types is not suitable for the application, other pumps may be considered with Principal's Authorised Person's Approval.

Waterways through pumps shall be smooth in finish and free from recesses and obstructions.

Pumps up to and including 80mm branch diameter may be single shaft with flange mounted drive motors. Pumps over 80mm branch diameter shall be close coupled with spacer coupling to enable pump rotating element removal with minimum disturbance of the drive motor. The pump casing shall be supported independent of the pipework.

The direction of pump rotation shall be clearly and permanently marked on the pump casing.

11.2 Impeller

The impeller shall be with high efficiency and non-clogging properties relevant for the type of fluids is pumping. The impeller shall be capable of passing the minimum size sphere specified.

The fixing of the impeller to the shaft shall be by a suitable method to prevent it becoming loose or fall off the shaft under any possible operating conditions including reversed rotation.

11.3 Pump Motor Shaft

The common pump/motor shaft shall be of a robust construction to withstand maximum stresses, vibrations and whirling under all operating conditions. The shaft shall be fully shrouded with sleeves throughout the pumped liquid way and seal spaces and shall be stepped at each sleeve and impeller. The shaft assembly shall be such as to preclude entry of water to the bearing housing and permit axial adjustment of the impeller. The shaft and the motor rotor shall be dynamically balanced as an integral assembly.

11.4 Split Case Pumps

11.4.1 General

The pumpset orientation shall be as specified in the Schedule. Mounting arrangements shall be designed to facilitate accurate alignment and prevent excessive distortion under all operating conditions.

Motors shall be horizontally mounted unless an alternative mounting arrangement is approved by the Principal's Authorised Person. Motor drives for horizontal pumps shall be mounted on a baseplate.

As specified in the Schedule, motor drives for vertical pumps shall be mounted on to a free standing frame fixed rigidly to the floor and connected to the pump using a flexible spacer coupling.

A dimensioned general arrangement drawing of the pumpset shall be provided with the Tender. This shall indicate, where appropriate, the minimum clearance distance required for the removal of components (for refurbishment or replacement) with the pumpset in situ.

11.4.2 Casing

The casing material shall be as specified in the Schedule.

The casing shall be designed to resist abrasion and mechanical shock imposed by solids in the pumped flow.

Casings shall be split axially.

To allow the removal of the rotating components, the casing shall be designed so that the removable half can be removed without disturbing the fixed half-casing and system pipework and frame work. If the means provided to permit the lifting of the removable half is of insufficient strength to provide the means of lifting the whole weight of the pumpset, this shall be clearly indicated.

The casing halves shall be accurately aligned during assembly to match the volute profiles and be doweled to ensure certain repositioning during re-assembly. Means shall be provided to facilitate the separation of the casing halves. On larger castings this shall be by two or more stainless steel jacking screws/bolts

The casing casting shall be dressed to a good commercial standard to expose any surface imperfections.

The inlet and outlet flange details shall be as specified in the Schedule. Unless otherwise specified in the Schedule, the inlet and outlet connections of the pump shall terminate with flange with a minimum rating of PN16 according to AS4087. Grey cast iron flanges type PN14 and over shall be acceptable with prior approval from Principal's Authorised Person.

All casing surfaces having a fine clearance between fixed and rotating components shall incorporate renewable wear parts that are easily removable for refurbishment or replacement.

If, as specified in the Schedule, renewable wear parts are provided, they shall be fixed in place by the method specified in the Schedule. The renewable wear part material(s) shall be as specified in the Schedule.

If, as specified in the Schedule, an internal coating is required for corrosion protection and /or efficiency enhancement, the coating specification, thickness, efficiency increase and expected life shall be as specified in the Schedule.

The direction of rotation of the impeller shall be clearly and permanently marked on the pump casing with an arrow.

If specified in the Schedule, connections shall be provided on the pumpset flanges or casing for connection of inlet and outlet pressure gauges, venting, drain and seal flushing pipework. These shall consist of bosses appropriately drilled and tapped, with a minimum size of 3/8 inch BSP(T). Venting connections shall be positioned on the highest practicable point on the casing. All unused, tapped holes shall be fitted with solid, corrosion resistant, metal plugs.

If specified in the Schedule, for applications where the Supplier is also providing the inlet/outlet pipework, tappings shall be provided for the connection of performance monitoring sensors. These shall be positioned at least 2 x pipe diameters away from the inlet/outlet branches of the casing and have a minimum size of 1/2 inch BSP(T).

The casing shall be specifically designed for its intended mounting arrangement using support feet machined to a suitable surface finish and incorporating holes drilled and spot faced for holding down bolts. The feet shall accommodate and transfer all loads from the pumpset to its intended mounting arrangement.

11.5 BACK PULL OUT PUMPS

Back pull-out pumps shall be of true back pull-out design.

The pump assembly shall allow the pump bearing frame and impeller to be backed out of the volute without disturbing the pump piping connections. The pump shall provide easy disassembly for maintenance and impeller trim.

The pump shall have an integrally cast support and mounting foot located directly beneath the pump volute.

The pump assembly shall have:

- A construction that permits the bearing frame and impeller to be easily backed out of the volute.
- A rigid mounted, foot supported volute
- A centre drop-out or spacer type coupling

Single stage end suction back pull out pumps shall be in accordance with ISO 2858, ISO 3069 & ISO 3661.

Pumps up to and including 80 mm branch diameter may be single shaft with flange mounted drive motors. The pump casing shall be supported independent of the pipework. Pumps over 80 mm branch diameter shall be close coupled with spacer coupling to enable pump rotating element removal with minimum disturbance of the drive motor.

The rotating element shall be statically and dynamically balanced before final assembly.

Pump shafts shall be of steel and fitted with stainless steel or equal renewable sleeves.

Suction Compound and Delivery Pressure gauges shall be fitted to each pump. Each gauge shall be at least 150 mm diameter, be fitted with an isolating cock, and be graduated in metres head of water and bars gauge. The gauges shall be mounted on a common gauge board for each pump. Pumps shall be fitted with air release cocks at the highest point of the casing, and with a drain cock at the lowest point.

12 AIR LIFT PUMP

One air lift pump shall be installed in the tank or well. The uptake pipe and discharge pipe shall be a minimum of 100mm diameter. The uptake pipe shall be 304 stainless steel.

The airlift pump shall be:

(a) Removable without the need to empty the tank

(b) Operated intermittently.

The air lift riser shall be equipped with a flanged tee and a flanged ball valve.

The air lift pump shall discharge into a pipe or channel operating under gravity conditions.

13 GRIT PUMP/WATER SPARGE ASSEMBLY

A grit pump/water sparge assembly shall be furnished to facilitate grit removal. The assembly shall consist of water (reclaimed) sparge and grit pump. The water sparge shall agitate the grit and then be pumped by the grit pump to the grit classifier. The water sparge shall be activated by a solenoid valve. The grit pump shall have a **recessed torque impeller** specifically designed for grit handling. The grit pumping system shall also have the facility to backflush the grit pump suction line with reclaimed effluent.

14 POSITIVE DISPLACEMENT PUMPS

14.1 General Requirements for Positive Displacement Pumps

14.1.1 Casing

The casing shall be designed to resist abrasion and mechanical shock imposed by solids in the pumped flow.

The casing material shall be as specified in the Schedule.

The casing casting shall be dressed to a good commercial standard to expose any surface imperfections.

Components in the pumpset casing that may be subject to wear shall be easily removable for refurbishment or replacement.

All mating surfaces shall be accurately machined and provided with deep registers, dowels and spigots where necessary, to ensure alignment.

If specified in the Schedule, connections shall be provided on the pumpset flanges or casing for connection of inlet and outlet pressure gauges, venting, drain and seal flushing pipework. These shall consist of bosses, appropriately drilled and tapped, with a minimum size of 3/8 inch BSP(T). Venting connections shall be positioned on the highest practicable point on the casing. All unused, tapped holes shall be fitted with solid, corrosion resistant, metal plugs.

The inlet and outlet flange details shall be as specified in the Schedule. Unless otherwise specified in the Schedule, the inlet and outlet connections of the pump shall terminate with flange type PN16 according to AS4087. Grey cast iron flanges type PN14 and over shall be acceptable with prior approval from Principal's Authorised Person.

The inlet and outlet connections shall be able to be re-oriented in a maximum of 90° steps.

If specified in the Schedule, the inlet branch of the casing shall incorporate access ports to allow the clearance of blockages and the inspection of rotor drive components.

14.1.2 Stator

The stator material shall be as stated in the Schedule.

If specified in the Schedule, a method of stator adjustment shall be provided to compensate for stator and/or rotor wear.

14.1.3 Drive assembly

The drive system shall enable easy dismantling of the pump. The drive shaft and mechanical seal, where fitted, shall be replaceable without the need to dismantle the bearing housing.

14.2 Progressive Cavity Pumps

14.2.1 General

Progressive cavity pumps shall be heavy duty, industrial, low speed units that comprise a helical rotor which rotates within an elastomeric stator.

The pumps shall be self-priming and provide positive displacement, low shear effects and a flow proportional to the pump speed.

Progressive cavity pumps shall be of a single pitch helical rotor and double pitch stator, high efficiency design. The materials selected shall provide good abrasion resistant, low NPSH characteristics and positive non-turbulent flow, over the full range of operating conditions.

The pumps shall be fitted with devices which protect them against dry running conditions, excessive pressure on discharge side and excessive vacuum on suction side.

The pumps shall be supplied with a mechanical seal. The gland packed stuffing box type will not be accepted.

The progressive cavity pumps shall have a rotor speed that does not exceed that recommended by the manufacturer as being suitable for the abrasive properties of the material being pumped and the materials selected for the rotor and stator. Regardless, rotor speeds greater than 200 rpm will only be allowed if specifically approved by the Principal's Authorised Person.

A dimensioned general arrangement drawing of the pumpset shall be provided with the Tender. This shall indicate, where appropriate, the minimum clearance distance required for the removal of components (for refurbishment or replacement) with the pumpset in situ.

The pumpset shall operate alone, in parallel or in series as specified in the Schedule.

If a multi-stage pumpset is required/provided, the number of stages shall be as specified in the Schedule.

If specified in the Schedule, the pumpset shall incorporate a solids handling mechanism to ensure a continuous feed into the rotor.

14.2.2 Rotor

Unless otherwise specified in the Schedule, the rotor shall be electrolytically chromium plated in accordance with BS 4641, and have a minimum coating thickness of 200 μm in the area of the rotor major diameter.

The maximum rotor speed and the maximum stator/rotor rubbing velocity shall be as specified in the Schedule. The maximum speed of the pumpset shall be de-rated and the pressure per stage limited according to the level of abrasive solids present in the pumped medium in accordance with the table below.

Level of Abrasive Solids	Maximum Pressure per Stage (bar)	% Speed De-rating
None	6	0
Light	5	25
Medium	4	50
Heavy	3	75

14.2.3 Materials

The materials of construction for progressive cavity pumps shall be at least equal in quality to the following:

COMPONENT	MATERIAL	STANDARD
Baseplates	Steel, Galvanised	AS 3678 Grade 250
Casings	Cast Iron	AS 1830 Grade T200
Rotors	Stainless Steel	AISI Grade 316 - Hard chrome plated
Stators	Elastomer	*
Shafts	Stainless Steel	AISI Grade 416
Nuts and Bolts:		
• Non-Wetted Parts	Stainless Steel	AISI Grade 316
• Wetted Parts	Stainless Steel	AISI Grade 316
Studs	Steel	AS2528
Anchor Bolts	Stainless Steel	AISI Grade 316
Guards	Galvanised	AS 3678 Grade 250

Elastomer to be selected to suit fluid being pumped, e.g. natural rubber for sludge, nitrile rubber for Polyelectrolyte.

The pump shall be supplied with a bearing housing so that it does not rely on the motor bearing to support the pump rotor.

If a coupling rod and joints are used, they shall be sealed for life.

The profile of the coupling rod and joints shall be designed to avoid entanglement of fibrous material.

14.2.4 *Drive assembly*

The pumps shall be fitted with flexible couplings and/or vee-belt drives. V-belt drives may be supplied only with approval of the Principal. Flexible couplings shall be of the cone-ring or flexible element type, rated to suit the torque output under all loading conditions. Where vee-belt drives are fitted they shall be sized such that there is a minimum of two belts on any pulley, and that the belt drive is rated at a minimum of 50% more than the installed motor power. Vee-belt drives shall comply with AS 2784.

14.3 Ram/plunger pumps

14.3.1 General

The number of pump cylinders shall be as specified in the Schedule.

If, at the rated operating conditions, pulsation dampers are required on the pumpset inlet and/or outlet to achieve the pumpset component lives and/or reduce pressure peaks to acceptable levels these shall be included.

If cylinder liners are fitted, the cylinder liner material shall be as specified on the Schedule.

If cylinder liners are fitted, they shall be readily accessible for replacement purposes.

The ram/plunger material/coating combination shall be as specified on the Schedule.

If specified in the Schedule, the connecting rod shall be chromium plated to BS 4641.

Seals shall be capable of replacement without removing the plunger/connecting rod.

14.3.2 *Drive – General*

The type of drive shall be as specified in the Schedule.

14.3.3 Non Return Valves - General

Pumpsets shall be fitted with ball or ‘duckbill’ type non return valves as specified/stated in the Schedule.

Valves shall be provided with covers to facilitate the replacement of wearing parts and the manual clearance of blockages. If specified in the Schedule, these covers shall be provided with quick release fittings.

Valves shall be designed to prevent chatter. If specified in the Schedule, a method of adjusting the response of valves to hydraulic fluctuations in the system shall be provided.

14.3.4 Non Return Valves - Ball valves (if required)

Bias flow conditions shall be created within the valves during operation that rotate the balls and spread wear evenly over the sealing areas.

Unless otherwise specified in the Schedule, balls shall be coated with a polyurethane elastomer to improve seating performance.

14.4 Peristaltic pumps

14.4.1 General

The pumpset shall be self-priming and permit pumping in either direction without reverse flow of liquids, slurries or suspensions.

The pumpset shall be designed so that liquids, slurries or suspensions are retained within the casing in the event of a hose/tube burst.

Peristaltic and reciprocating pumps shall be provided with air vessels or pulsation dampers of ample size to effect smooth rates of discharge.

14.4.2 Pulsation dampeners

If, at the rated operating conditions, pulsation dampers are required on the pumpset inlet and/or outlet to achieve the hose/tube life stated in the Schedule and/or reduce pressure peaks to acceptable levels (consult Purchaser for further information, if required), this requirement shall be stated in the Schedule.

14.4.3 Pump Casing

The casing shall be provided with a bolted, removable front cover to enable the rotor, hose and bearing assemblies to be removed without disturbing the inlet/outlet pipework.

Front covers weighing over 25 kg shall be hinged or provided with suitable lifting points. Front covers weighing less than 25 kg shall be provided with handles to facilitate removal/replacement.

The casing shall incorporate the bearing housing, which shall be accessible via a removable cover plate.

If specified in the Schedule, connections shall be provided on the rear of the casing to prevent accidental damage/facilitate the removal of the front cover, for the following:

a) A means of relieving the pressure in the casing in the event of a hose/tube burst;

b) Breather tubes to accommodate expansion/contraction of the hose lubricant;

c) High and low lubricant level probes; and/or

d) Lubricant fill/drain points. These shall consist of bosses appropriately drilled and tapped. All unused tapped holes shall be fitted with solid, corrosion resistant, metal plugs.

14.4.4 Hose/Tube and Connections

The hose/tube material shall be as specified in the Schedule.

The hose/tube shall be easily replaceable. If local control of the drive system is required during hose replacement, this shall be stated in the Schedule.

A burst hose monitoring facility shall be provided.

The hose/tube shall be connected to the inlet and outlet pipework using the type of connections specified in the Schedule.

14.4.5 Hose/Tube Lubricant

The sliding interface between the hose/tube and shoe/roller shall be lubricated by partial immersion in a lubricant bath. The type of lubricant shall be as specified on the Schedule.

Provision shall be made for draining and replenishing the lubricant without spillage.

14.4.6 Shoes/Rollers

Compression of the hose/tube shall be effected by shoes/rollers as specified in the Schedule. The number of shoes/rollers shall be as specified in the Schedule.

The shoe/roller material shall be as specified in the Schedule.

Shimming facilities shall be provided for the shoes/rollers to enable pumping performance to be optimised.

The shoe/rollers shall be easily accessed and replaceable.

14.4.7 Rotor

The rotor material shall be as stated in the Schedule.

The rotor shall be securely keyed to the drive shaft. Shaft rotation shall not be relied upon to ensure the rotor is locked in position.

14.4.8 Seals

Shaft seals shall be provided to prevent leakage of hose/tube lubricant from the casing and bearing lubricant from the bearing housing.

14.5 Diaphragm pumps

14.5.1 General

The pumpset shall be self-priming and capable of dry running without damage.

The pumpset shall be designed such that the drive assembly and diaphragm can be replaced without disturbing the inlet/outlet pipework.

14.5.2 Pulsation dampers

If, at the rated operating conditions, pulsation dampers are required on the pumpset inlet and/or outlet to achieve the diaphragm life stated in the Schedule and/or reduce pressure peaks to acceptable levels (consult Purchaser for further information, if required), this requirement shall be stated in the Schedule.

14.5.3 Diaphragm and Diaphragm Retainer Plate

The diaphragm material shall be as specified in the Schedule. The diaphragm retainer plate material shall be as specified in the Schedule. If specified in the Schedule, a means of detecting diaphragm failure shall be provided.

14.5.4 Non Return Valves

Pumpsets shall be fitted with ball or ‘duckbill’ valves as specified in the Schedule.

Bias flow conditions shall be created within the valves during operation which rotate the balls and spread wear evenly over the sealing areas.

Unless otherwise specified in the Schedule, balls shall be coated with a polyurethane elastomer to improve seating performance.

14.5.5 Crank, Bearing, Connecting Rod and Cushioning Spring

If specified in the Schedule, a variable stroke connecting rod shall be provided. If specialist tools are required for adjustment of stroke, these shall be provided with the pumpset.

The connecting rod shall be spring loaded to prevent hydraulic lock and/or cushion forces acting on the diaphragm due to solids trapped beneath it. Solid connecting rods shall not be used.

The drive end of the connecting rod shall incorporate a rolling element bearing. Plain bearings shall not be used. The bearing shall be provided with an accessible lubrication point (remote if required).

14.5.6 Pulsation dampers

If, at the rated operating conditions, pulsation dampers are required on the pumpset inlet and/or outlet to achieve the diaphragm life and/or reduce pressure peaks to acceptable levels these shall be included.

14.5.7 Diaphragms, trunnions and retainer plates

The diaphragm material shall be as specified in the Schedule.

The trunnion material shall be as specified in the Schedule.

The diaphragm retainer plate material shall be as specified in the Schedule.

If specified in the Schedule, a means of detecting diaphragm/trunnion failure shall be provided.

14.5.8 Driveshaft, eccentric bearings and support bearings

The driveshaft shall possess adequate torsional and axial stiffness to prevent excessive distortion under all operating conditions.

All bearings shall be adequately lubricated to prevent excessive wear/seizure under all operating conditions.

14.6 Rotary lobe pumps

14.6.1 General

The pumpset shall be of twin rotor design with lobed rotors mounted on separate parallel shafts, counter rotating within the pump casing.

Shaft rotation shall be synchronised to ensure that no contact occurs between the rotors and/or the rotors and the pump casing.

The pumpset shall be designed to permit pumping in either direction with minimum reverse flow of liquids, slurries or suspensions.

14.6.2 Performance

Pumps shall be designed to satisfactorily pump solids of required sizes.

Freedom from choking is essential and is more important than high pumping efficiency.

Pumps shall be designed to have a stable head/ quantity characteristic so as to avoid large changes of quantity with small changes of head.

14.6.3 Materials

Pump bodies, covers, brackets, bearing housings, wearing plates, eye ring lifting points, support brackets etc., shall be as specified in the Schedule.

Pump casings shall be of substantial construction to give long life under abrasive conditions and to enable them to withstand shock loads caused by solids in suspension.

Impellers shall be of material specified in the schedule and shall be keyed onto shafts.

Shaft shall be of high tensile steel/other as specified in the schedule and of adequate size to avoid the possibility of fatigue failure.

14.6.4 Casing

The casing shall incorporate a front cover plate that can be easily removed to allow access to the rotors. Sacrificial inserts shall be fitted in the front cover plate to allow for wear. Alternatively, reversible front cover plates may be provided.

Front covers weighing over 25 kg shall be hinged or provided with suitable lifting points, as specified in the Schedule. Front covers weighing less than 25 kg shall be provided with handles to facilitate removal/replacement.

The casing shall be fitted with positively located wear plates at the back of the rotors to enable rotor-to-casing tolerances to be adjusted to their optimum value. If specified on the Schedule, positively located radial wear plates shall also be fitted. All wear plates shall be easily replaceable without disturbing the inlet/outlet pipework.

Pump casings shall be of substantial construction to give long life under abrasive conditions and to enable them to withstand shock loads caused by solids in suspension.

14.6.5 Rotors

The number of rotor lobes shall be as specified in the Schedule.

The rotor material/coating combination shall be as specified in the Schedule.

If specified in the Schedule, the rotors shall be provided with replaceable tips.

The rotors shall be replaceable in-situ.

The rotors shall be retained in position by torque locking assemblies and splines. Any special tools required for the removal, adjustment and installation of rotors shall be supplied with the pumpset.

The rotors and shaft shall be marked to ensure correct alignment/synchronisation on re-installation.

14.6.6 Timing gearbox- Casing

The casing shall have integrally cast mounting feet with machined faces.

The casing shall incorporate accessible oil filling and drain plugs that allow in situ oil removal/replenishment without excessive spillage. An oil level window/sight glass shall be provided.

The casing shall include machined spigots and/or dowels to ensure accurate alignment with the reduction gearbox casing.

The casing shall be supplied with shims for correct assembly with the pump casing. Unless otherwise specified in the Schedule, shims and packers for holding down purposes shall also be provided.

14.6.7 Timing gearbox – Shafts

Shafts shall be of one-piece construction, machined all over. Both shafts shall incorporate integral timing gears to enable synchronous rotation.2. Shafts shall be sized to accommodate all possible loads over the specified operating range of the pump, including direct-on-line (DOL) starting. The first critical shaft speed shall be in excess of the maximum shaft speed.

Shafts shall be individually withdrawable for maintenance.

The input shaft end shall be manufactured to BS 4506 to accept a standard coupling to BS 3170.

The maximum shaft deflection should not exceed 0.05 mm at the location of the mechanical seal faces when operating at duty flowrate and 0.1 mm at minimum continuous flowrate.

Pumps shall be supplied with large bore seal chambers suitable for modern mechanical seal design. Gland packing shall not be used. Vendor shall provide dimensions of seal chamber with bid.

14.6.8 Timing gearbox - Gears and lubrication

Timing gears shall be precision manufactured, in volute form spur or helical gears. The gearbox shall be designed to accommodate any thrust forces generated by the timing gears.

The timing gears shall be provided with a common oil chamber to the bearings.

The method of timing gear lubrication and grade of oil shall be as specified in the Schedule.

If specified in the Schedule compound gauges shall be fitted to the suctions of pumps installed in dry wells, and pressure gauges to the deliveries of all pumps. If gauges are not required

14.6.9 Timing gearbox - Bearings and lubrication

The bearing manufacturer and manufacturer's bearing designations shall be as stated in the Schedule.

Unless specified otherwise in the Schedule, all pump bearings shall have a theoretical L_{10h} life of 26,000 hours at the guaranteed duty point (GDP). The actual bearing L_{10h} life at the GDP shall be as stated in the Schedule.

If specified in Schedule, the bearings shall be provided with separate oil chambers to eliminate immersed running of the lower bearings.

The method of bearing lubrication and grade of oil shall be as specified in the Schedule.

Bearing housings shall be designed to prevent the ingress of dust and water.

15 POLYMER DOSING PUMPS

The polymer dosing pumps shall be **positive displacement progressive cavity type pumps** for dosing polymer solution from the holding tank to the required dosing points.

The pumps shall be variable speed pumps controlled by the SCADA.

The pumps shall comply with pumps specification requirement.

The polymer dosing pumps shall be fitted with pressure relief valves on the discharge lines.

When the pressure relief valves are actuated the polymer solution will be discharged back into the holding tank. The discharge shall be at a visible location to monitor unnecessary leakage through relief valve.

The suction pipework on each dosing pump shall be fitted with a transparent calibrated cylinder with appropriate valving to allow the feed rate of the pumps to be measured and calibrated with the variable speed drive unit. The capacity of the cylinders shall be such as to allow a minimum time of 10 seconds to empty with the pump at full speed.

16 CHEMICAL DOSING PUMPS

16.1 General

The chemical dosing pumps shall be **positive displacement type** as indicated in the Schedule. The pumps shall be either mechanically or hydraulically operated diaphragm dosing units, solenoid pulse units, peristaltic or progressive cavity pumps.

The pumps shall be capable of the flows, heads and turndowns stated in the Schedules.

16.2 Capacity

The chemical metering pumps shall be of sufficient rated capacity and number and with adequate turn down to achieve the complete range of dosing flowrate requirements for each of the required dosing points.

16.3 Materials

Pump components and piping shall be suitable for the intended chemical use. The contractor shall confirm that the materials offered are compatible with the process liquid and for the specified service conditions and service life period.

16.4 Dosing Rate adjustment

The dosing pumps shall be provided with automatic adjustable feed rate by means of speed and stroke length adjustment. Minimum and maximum operating speeds shall be limited to those approved by the supplier and/or manufacturer to prevent overheating, excessive wear or damage. The stroke length shall be manually adjustable with 0 to 100 percent capacity control while the pump is in operation. Controls shall provide positive repeatable settings within plus or minus 2 percent over the entire range. Pump delivery shall be repeatable within plus or minus 1 percent accuracy.

Each pump shall be provided with the supplier's standard manual vernier, or digital indicating stroke positioner, readable to within ¼ of 1% of full stroke. A locking device shall be incorporated on the stroke positioner to prevent accidental adjustment of stroke.

16.5 Casing

The main body of the pumps, containing gears, reciprocating and variable stroke mechanism etc., shall be contained in a substantial metal/plastic casting pump body to ensure correct alignment and rigidity. The casing material shall be suitable for use with the chemical pumped.

16.6 Valves, fittings and appurtenances

The contractor shall provide all valves, fittings and pipework necessary for the proper operation of each dosing system.

The pump shall have a strainer upstream to trap impurities. The strainer shall be capable of being cleaned without having to drain the tank. The chemical dosing pump suction and discharge connections shall be constructed for easy access and/or removal.

Back pressure valves on each pump discharge line shall be provided with a minimum backpressure setting of 100kPa gauge. Backpressure regulators shall be of polyvinyl chloride (PVC) or UPVC construction, and shall have Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect the upper works of the valve from process fluid.

Pressure relief valves shall be provided for each dosing pump. Relief valves may be integral with the pumps or separate. Pressure shall be factory set and field adjustable.

16.7 Anti-siphon device

An anti-siphon device, such as a back pressure valve, shall be fitted on each pump discharge that shall prevent the tank contents from flowing through the pump when the pump is not in operation. Self-priming

16.8 Pump Suction

Self priming of pumps are required. The pump should be capable of pumping the tank empty without the need to prime the pump. The suction pipe to the pump shall have a 'Y' type strainer with isolation valves immediately before and after the strainer and permit full removal of the strainer . Parallel strainers are only required where it is essential to maintain a flow of dosing chemical at all times. If parallel strainers are installed, then they shall be installed adjacent to each other in the same horizontal plane (not one above the other where vapour locking can occur). Clearance around the strainer is to be provided to permit removal of the strainer element and the entire strainer body.

Pump suction is to be located at or below supply tank.

For specific gassing chemicals like sodium hypochlorite, the dosing pump shall be fitted with a degassing head.

16.9 Lubrication

Lubrication shall be by means of an oil bath with facilities for checking and topping up of oil levels.

16.10 Protective coating

Pumpsets shall be provided with a protective coating of chemical resistant paint, appropriate to the chemicals being dosed, applied in the factory.

16.11 Testing and calibration

All components subject to pressure shall be hydraulically tested to 150% of rated pressure.

Inlet pipework to chemical dosing pumps shall be connected to draw from a suitable calibration vessel with a capacity between maximum and minimum graduations equivalent to approximately 30 seconds pumping at maximum pumping rate).

Calibration tube and magnetic flowmeter for calibration of the pump shall be provided. The piping arrangement for the calibration cylinder shall be to have individual lines to each pump suction (tie-ins between the pumps and the pump's isolation valves). The vent from each calibration cylinder shall be hard piped back to the tank. There shall be no other pipes tied into this vent line (to avoid interference when using the calibration cylinder). Also, there shall be no pump suction degassing lines installed which will interfere with the calibration. If one is required then it shall include an isolation valve to prevent interference with the use of the calibration cylinder.

16.12 Pulsation Dampeners

The contractor shall provide pulsation dampeners in the discharge pipework from each metering pump, as a minimum, and also for the suction lines (if needed), which are suitably sized for the displacement and discharge pressures of each pump.

Each pulsation dampener shall be designed and sized for the particular pump such that the fluctuation of the discharge pressure is limited to $\pm$ 10%. The pulsation dampeners shall be of the diaphragm type separating the air chamber from the liquid chamber and shall be of suitable materials for the duty, chemicals and location of installation. The air chamber is to be pressurised and be capable of re-pressurising by an airpump via a “Schrader” (or equal) valve.

16.13 Mechanically Driven Pumps

Each pump shall be driven by an electric induction motor via a gear arrangement (i.e. not belt driven) and shall have a variable speed drive such that the flow rate is controlled and in proportion to the drive speed.

The main body of the pumps, containing gears, reciprocating and variable stroke mechanism etc., shall be contained in a substantial metal casting pump body to ensure correct alignment and rigidity. Lubrication shall be by means of oil bath with facilities for checking and topping up of oil levels.

Metal parts which are normally, or may occasionally, be in contact with the pumped chemical shall be manufactured in stainless steel or other approved corrosion-resistant material. Pump heads shall be manufactured from stainless steel or other approved material with PTFE diaphragms. Pump valves shall be ball type, made of stainless steel and PTFE or nitrile rubber. All components subject to pressure shall be hydraulically tested to 150% of rated pressure. Inlet and outlet connections shall be suitable for pipework with screwed union type joints.

17 ELECTRONIC DOSING PUMPS

Electronically controlled, solenoid operated dosing pumps shall be substantially constructed and suitable for long-term reliable operation.

The frequency of stroke shall be automatically adjustable for dose control, and also capable of manual overriding adjustment: both automatic and manual adjustment shall be possible whilst the pump is running.

The pump stroking speed control system shall be of solid state design providing variable stroking rate proportional to liquid flow rate. The stroking speed range shall be continuous between 10%-100% of maximum.

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