OMAN WASTEWATER SERVICES COMPANY S.A.O.C

الشركة العمانية لخدمات الصرف الصحي ش.م.ع.م

OMAN WASTEWATER SERVICES CO. S.A.OC.

TECHNICAL STANDARD SPECIFICATION

PUMPS, COMPRESSORS, BLOWERS AND CUTTERS

SECTION 03

Table of Contents

	Description	Page
3	**Pumps, Compressors, Blowers and Cutter**	**3/33**
3.1	Pumps	1/33
3.2	Air Blowers & Compressors	15/33
3.3	Cutting Devises	21/33

Appendices

Appendix A - Sludge Pump Selection Matrix
Appendix B - Dosing Pump Selection Matrix
Appendix C - Clean Water Pump Selection Matrix

3. Pumps, Compressors, Blowers and Cutters

3.1 Pumps

3.1.01 General

The pumping installation shall be carried out to the satisfaction and in accordance with the Acts and by-laws of the Ministry of Housing Electricity and Water (MHEW).

Pumps shall be of suitable design for application see Appendix A, B and C for selection matrices.

All pumps shall be designed to withstand a test pressure of 1.5 times the maximum possible pump shutoff pressure under maximum suction pressure conditions. If a pump can operate at sub-atmospheric suction conditions, the entire pump shall be designed for full vacuum.

Pump materials of construction shall be suitable for application. Replaceable superior grade wear parts shall be included when pumping fluids which include grit/sand.

All pumps and pipe work shall be suitably protected against dry running, over pressure and low suction pressure. Where pressure relief valves are fitted to the discharge line of any pump they shall be arranged to feed back to the suction side of the pump.

Pressure sensing devices shall not come into contact with the fluid being pumped unless specifically suitable for application.

Common suction and delivery mains shall be provided with 2 tappings each fitted with 1/2” BSP valves for pressure gauge and transducer connections.

Shaft seals shall be cartridge type bellows mechanical seals. Only where these are not suitable shall packed glands be considered. Any pump fitted with packed glands shall have a replaceable pumping sleeve over the shaft within the gland.

Tapped bosses shall be provided on the pump casing for air release, draining and suction and delivery pressure readings. The air release valve and pipework shall be included.

Bearing housings shall be grease retaining and dust proof. Each bearing shall be grease lubricated.

Motors shall be sized in accordance with the following table:

Absorbed Power at Duty Point (P_{abs})	Motor Installed Power
≤ 10 kW	P_{abs} + 25% or end of curve power + 10%, whichever is greater
> 10 kW < 50 kW	P_{abs} + 10% or end of curve power + 5%, whichever is greater
> 50 kW < 100 kW	P_{abs} + 10%
≥ 100 kW	P_{abs} + 5%

3.1.02 Hydraulic and Constructional Requirements

On Sewage pumps, hydraulic efficiency may be reduced in order to ensure freedom from blockage. Where practicable, all pumps shall be capable of passing a sphere, sized equivalent to the bore of the outlet flange. For an outlet flange bore of 100mm and above the minimum sphere size shall be 75 % of the outlet flange bore. Where a closed impeller is unable to achieve this, an alternative design of impeller, pump or pumping system suitable for the application may be offered.

Vortex type pumps shall only be used with the permission of the Employer prior to Tender return unless for pumping liquids with a high grit content.

Consideration shall be given to pumps with reduced through lets if cutting devices or innovative designs are proposed, with the written permission of the Employers Representative prior to tender return. Cutting devices shall not be used unless absolutely necessary due to the high cost in maintenance and spares.

The pump outlet flange bore and Impeller passageways shall be as large as possible consistent with good design. The leading edges of impeller vanes shall be rounded and smooth to reduce the tendency for rags and fibres to build up.

For sewage & sludge applications common suction and delivery mains should be provided with 2 off 1” BSP tappings fitted with valves for fitment of diaphragm type pressure gauges.

Where responsible for the system design, the Contractor shall;

- Carry out a full assessment of the total pump head and suction conditions at the duty point, submitting calculations for the station and system friction losses. Losses shall be evaluated for pipe work in both new and estimated worn conditions to ensure the suitability of pump selection.
- Ensure that the pump selected is suitable for the Net Positive Suction Head available (NPSHA).
- Submit a graphical plot of system characteristics and pump performance curves (including efficiency, power and NPSHR) superimposed on each other.
- For optimum performance and economic considerations, the duty point on the head/flow curve shall lies between 80 % and 105 % of the Best Efficiency Point (BEP).

For pump sets with variable speed drives the best overall efficiency shall be obtained.

3.1.03 Vibration and Balancing

Following completion of assembly, all rotating parts shall be statically and dynamically balanced. Balancing certificates shall be submitted to the Employer for acceptance.

The contractor shall supply all required vibration isolation systems such that:

- All pipework and ducting shall be isolated from plant born vibration.
- The vibration of machinery when installed on site and operating within its normal operational duty range shall meet the requirements of BS 7854, evaluation zone B. The contractor shall carry out tests to confirm this.
- During operation, should the machinery require remedial action to reduce the level of vibration to the above requirements, the Contractor shall be responsible for rectifying any problems.

3.1.04 Pump Works Testing

All pumps with an installed power of 30 KW and above shall be factory tested.

All test curves and certificates shall be included within the O&M Manuals.

As a minimum requirement, the performance testing of pumps shall be carried out as follows:

3.1.05 Hydraulic Performance testing to BS EN ISO 9906

All pumps with motors between 30kW and 75 kW inclusive shall be factory tested without witness to Grade 2.

All pumps with motors of between 75 kW and 150kW inclusive shall be factory tested with witness to Grade 2.

All pumps with motors of above 150 kW shall be factory tested with witness to Grade 1.

NPSH tests shall be carried out on all pumps where the suction conditions are critical.

3.1.5 Mechanical Vibration Testing to BS7854-1 / ISO 10816-1

Vibration tests shall be carried out on pumps with motors above 75kW and shall not exceed vibration levels in Evaluation Zone B.

3.1.06 Inverter String Tests

Unless stated otherwise in the Particular Specification, pump-motor-inverter string tests will not be required. Pumps intended for operation at variable speed shall be tested at fixed speed as close as possible to the intended maximum speed.

3.1.07 Pump Pipe work

Long radius bends, radial tees and swept junctions shall be used wherever possible to reduce friction losses and improve flow characteristics. However this should not require an increase in the size of civil structures (e.g. valve chambers, pump sumps etc)

Care shall be taken to ensure that the suction pipework rises to the inlet of the pump, thus preventing air pockets from forming. Eccentric 'flat top' tapers shall be used on horizontally mounted suction pipework.

Flange adaptors and couplings shall be installed as necessary to facilitate the removal of plant and components without disturbance to the system. These shall be tied as necessary to resist thrust loadings. 'Uniflanges' or 'Flex lock' adaptors shall not be acceptable for this purpose.

Isolation valves shall be installed as necessary to enable any pump (in a two or more pump installation) to be isolated and removed without isolating the whole installation. Thus, care shall be taken when selecting wafer type valves, sandwiched between two flanges with through bolts. (One of the flanges may need to be withdrawn to facilitate removal of the pump).

Drain connections with valves shall be fitted to the suction & discharge pipework.

3.1.08 Submersible Sewage Pumps

Pumps shall be vertical spindle unshakeable single stage centrifugal type having radial or mixed flow impellers and shall be suitable for continuous running under complete or partially submerged conditions. They shall be specifically designed to handle sewage water containing 100 mm diameter spheres, rags, fibrous materials, grit and other wastes.

The maximum rotation speed shall be 1500 rpm.

The pumps shall be equipped with stator temperature guard as well as water leakage guard to oil- and stator housing.

The casing shall be high cast iron (fine grained mechanite) free from blow-holes or imperfections, or ample proportions throughout, with all internal passages finished smooth.

The impeller shall be single or double shrouded, statically and dynamically balanced, with interchangeable bearings and a ball clearance of at least 100 mm, non clogging type. Back vanes shall be provided on the discharge side shroud to minimize the ingress of abrasive matter to the shaft seal. The impeller, manufactured of high-grade cast iron shall be keyed to the shaft and secured by locking screws.

All studs, bolts, nuts washers and screws used in the construction of the pump units shall be of stainless steel.

The pump support will be a cast iron foot bend with pump coupling and sliding flange coupling for connection to the discharge pipe. A pump consisting of two guide rods from foot bend to pump deck, materials stainless steel, shall be installed. Hoisting cables, stainless steel with lock fixed to the pump shall be provided.

Motor cooling shall either be by pumped coolant in a cooling jacket or by heat transfer through the stator casing. The use of sewage or effluent as a pumped media coolant is not permitted.

If cooling is effected by heat dissipation then the motor rating shall be suitably de-rated.

Unless otherwise specified, seal protection shall be provided on all pumps with motors of 7 kW and above. Level sensors shall be configured to alarm in all cases.

3.1.09 Dry Well Centrifugal Sewage Pumps

If open coupled pumps, the motor shall be mounted on either a cast iron or fabricated steel stool at motor room level. The stool shall incorporate access holes to the motor coupling.

The drive shaft shall have flexible couplings at both ends. The pump operating speed shall be below the first critical speed of the shafting. Provision shall be given for access to the flexible coupling for maintenance and removal of the disc elements.

Where accepted, packed gland seal drains shall incorporate a tundish and pipe into a dry well sump.

A drilled and tapped boss shall be provided in the top of the pump casing to accommodate air release pipework which the Contractor shall supply. A drain cock shall be fitted to the lowest point.

The pump shaft shall be supported in an external bearing housing constructed in cast iron forming the cover of the pump, there being no internal bearings in the pump. Bearings shall be fitted to accommodate thrust in either direction, in addition to journal load and shaft weight. The driven end of the shaft shall be keyed to suit the coupling. Adjustment for positioning the impeller within the casing shall be by means of two thrust collars threaded onto the shaft at the driven end.

Pumps shall be supplied complete with suction bends each incorporating a large hand-hole and cover.

Pumps shall be mounted on substantial cast iron or fabricated steel stools, suitable for fixing to concrete plinths. All bolt holes shall be drilled to ensure complete inter-changeability when removals are necessary.

Access into the pump casing for inspection and cleaning purposes shall be provided in the form of a large hand hole and cover.

The pump shaft shall be constructed from stainless steel. A renewable sleeve shall be fitted to the shaft from the impeller extending through the seal area.

Pressure gauges, if required, shall be remotely mounted to avoid vibration damage.

3.1.10 Split Case Centrifugal Pumps

The design and construction of the pump set shall be suitable for the type and properties of the pumped fluid and comply with the following specification.

The pump set shall be suitable for the environment in which it is to be installed including any hazardous areas.

Unless otherwise agreed the maximum operating speed of the pump set shall be 1500 rpm.

The pump set hydraulic performance at the guaranteed duty point (GDP) shall be as specified.

The pump set shall be capable of continuous operation within the specified operating envelope.

The pump set shall have stable characteristics against the system curve.

The pump efficiency and absorbed power (bare shaft) at the GDP and maximum flow rate shall be as stated, in the coated and/or uncoated conditions.

The pump set shall be capable of operating against a closed valve i.e. at zero flow rate without damage for a minimum time period.

The pump set may be mounted in either the vertical or horizontal orientation.

Motor drives for vertical pumps shall be mounted either:

a) Directly onto the pump casing using an adaptor stool; or

b) Onto a free standing stool fixed rigidly to the floor and connected to the pump using a flexible spacer coupling; or

c) Remotely and connected to the pump by line-shafting.

Motor drives for horizontal pumps shall be mounted on a base plate.

To allow the removal of the rotating components, the casing shall be designed so that the top half-casing can be removed without disturbing the bottom half-casing and system pipework.

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.

The inlet and outlet flange of the pump shall terminate with flange type PN16 (minimum) unless otherwise agreed.

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.

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

Connections shall be provided on the pump set 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 impeller type shall be selected to provide the required hydraulic and physical requirements.

Each impeller shall be a one piece casting manufactured from materials selected for the fluid being pumped.

The Impellers shall not be pinned to the shaft; neither shall shaft rotation be relied upon to ensure that the impeller is locked in position.

Each impeller shall be dynamically balanced in two planes to prevent the pump set exceeding the maximum specified vibration levels. Balancing shall be achieved by machining, not addition of weights.

If impeller wear rings are not fitted, a machining allowance shall be provided on the impeller to accommodate the future fitment of wear rings.

If the shaft is exposed to the pumped liquid, it shall be manufactured from a corrosion resistant material or be protected by the use of a sleeve(s).

The first critical speed of the rotating element (i.e. shaft and impeller etc.) shall be at least 25 % above the maximum operating speed.

Unless otherwise agreed seals shall be mechanical gland type.

3.1.11 Drive Arrangements for Vertical Extended Spindle Pumps

The prime mover shall be provided with either a support mounting plate or stool suitable for bolting in place.

The motor stool or mounting plate shall have a machined register on the topside to match a similar register which will be provided on the base of the motor, so that the motor may be removed and replaced without disturbing the alignment.

Intermediate steel shafting between pump and prime mover shall be provided with universal couplings at the bottom and top ends. The coupling on the pump shaft shall be fitted on a sliding spline to allow vertical adjustment of not less than 25 mm.

All shafting shall be guarded up to the underside of the motor floor. Guards shall be demountable to facilitate shaft changes. Individual sections of guards shall not weigh more than 10 kg.

Shafting shall be dynamically balanced.

3.1.12 Archimedean Screw Pumps

The screw pump body shall consist of a centre tube constructed of mill certified A36 or BS 3601-360 steel (or equivalent), sealed at each end with rigidly designed steel end plates of the same quality steel. The centre tube shall be designed such that the pump deflection between the bearing centre lines does not exceed 4mm under all static and dynamic loads. Where two or more centre tube sections must be welded together to make the full length of the pump body, the additional sections shall be added equally to the two ends of the centre tube.

The tube ends shall be machined with registers to precisely locate the upper and lower bearing assemblies. Each of the bolt holes in the end plates for the bearing assemblies shall have a sealing plate welded to the inside face of the end plate to provide a water tight pump body.

Each torque tube shall be precision machined to ensure that the end plates are perpendicular to the pumps centre line axis. Each end face shall not exceed +/- 0.15mm from the true perpendicular to the pump axis, and +/- 0.15mm out of parallel to one another.

The screw flight shall be constructed from cold form steel to the same grade material as the pump body. The screw flights shall be continuously welded to the centre tube on both sides with full penetration welds. All radial welds between adjacent flight segments shall be full penetration welds on both sides of the flight. Each flight segment shall be positioned and welded in place such that each flight is

perpendicular to the centre tube. The outside pump diameter at the pump flights shall be machined to a uniform diameter that varies no more than 2mm from the theoretical radius measured from the centre line axis.

Reinforced A36 or BS 3601-360 steel (or equivalent) removable steel profile plates of a minimum 5mm thickness shall be supplied in approximately 1500mm sections for mounting on the uptake side of the screw pump. The profile plates shall act as an extension of the trough periphery and be designed to contain spillage.

The lower bearing assembly shall be constructed to allow continuous operation when fully submerged. The bearing shall be designed to remain in true axial alignment of the screw pump centre line through the lower and upper bearings for all operating conditions, and allow for the expected free axial expansion of the screw pump. The bearing arrangement shall consist of either of the sleeve type phosphor bronze bearing bush and high carbon content steel shaft, or spherical roller bearing. In both cases the bearing assembly shall be of adequate dimensions with a design life of not less than 100,000 hours.

The bearing assembly shall be completely protected by a stationary shroud to prevent material in the waste water from becoming wrapped around its rotating parts. The shroud shall be manufactured in two halves to facilitate its removal from the bearing housing. The design of the lower bearing shall be such that it can be replaced without removal of the base anchorage or the screw pump body.

The bottom bearing shall be grease lubricated by means of an automatic grease lubricator unit driven from the gearbox output shaft. Means shall be provided for adjusting the rate at which grease is supplied to the bearing. Grease piping must be stainless steel. Provisions must be made for manual of the bearing with grease and for clearing the grease piping of dry air pockets.

The upper bearing assembly shall consist of either a self aligning double spherical roller bearing or a combination of spherical roller and thrust bearings, mounted in a cast iron housing designed to withstand thrust and radial loads under all operating conditions. The bearing assembly shall be designed with a L10 life expectancy of not less than 100,000 hours. The upper bearing drive shaft shall be manufactured of a solid steel stub shaft fitted with either a cast iron hub flange or gusseted steel plate which matches the register on the screw pump end plate.

Each pump shall be driven by a totally enclosed, oil lubricated, air cooled, foot mounted Helical/bevel speed reducing gearbox. The gears and bearings shall be design for continuous operation and shall have design L10 life expectancy of not less than 200,000 hours at the rated power and speed. The gears and bearings shall be either splash or force lubricated to suit the size and mounting orientation of the reducer. The housing shall be complete with removable inspection covers, oil filler, drain and breather.

The output shaft of the gearbox shall be connected to the screw pump upper bearing shaft by means of a low speed flexible coupling. The coupling shall be designed to compensate for shocks, vibration and shaft miss-alignment. The coupling shall consist of two cast iron housing separated by flexible, non metallic rubber or elastomeric bushes. Replacement of the flexible elements shall not necessitate disassembly of the screw pump drive chain.

The gearbox and coupling shall be suitable for continuous duty with moderate shock loading and sized for not less than the greater of either 1.5 times the absorbed power or 1.0 times the motor rated torque at the screw pump design rpm.

The electric motor shall be connected to the gearbox via a V-belt drive and shall be mounted on a robust adjustable motor slide base. The motor shall be of sufficient capacity to operate the screw pump under all conditions and shall operate at less than 90% of its power rating when the pump is discharging at its maximum capacity and lift. The motor speed shall be a maximum of 1450 rpm.

Guards and splash plates shall be provided to protect equipment and personnel from spray and the rotating elements of the screw pumps. The guards shall be fabricated in a neat and substantial manner and shall be easily removable for inspection and maintenance purposes.

The screw pump shall be equipped with an anti-rotation device to prevent back rotation on power failure or stopping of the screw.

Bearing monitoring equipment shall be fitted to all pumps over 100kW to monitor upper & lower bearing wear, the lower bearing monitor shall be of a submersible type.

3.1.13 Progressive Cavity Pumps

The Contractor shall select suitable materials for the rotor and stator with due consideration to the material to be pumped. Aluminium shall not be used in the fabrication of the pump's wetted parts. The rotor shall be stainless steel but may be coated to increase durability should the Contractor deem this required in order to attain the design life stated in this specification.

The pumping element shall consist of a single helix rotor revolving eccentrically within a double helix resilient stator.

The Suction Chamber shall be capable of rotation to any of three positions 90 degrees apart so that the simplest piping arrangement can be devised. A drain plug shall be fitted to suit the chosen orientation.

A clean out cover shall be provided on the suction casing.

The pump speed shall be carefully selected to ensure a long service life. On no account shall the speed exceed 350 rpm for light sludge and 250 rpm for primary and heavier sludge. In all cases the rubbing velocity between the rotor and stator shall not exceed 1.5m/s.

The connection between the motor and pump shall be either a flexible drive shaft or a sealed rugged universal joint with a metal / rubber protection sleeve.

The pump shall be driven either through a gearbox or by piggyback 'V' belt drive.

Pump components and materials shall be suitable for pumped medium.

The pump casing shall be capable of being fitted with a replacement rotor and stator ensuring that either can be withdrawn within the confines of the surroundings. Tapped bosses shall be provided for drain and suction and delivery gauge connections. The pipe work shall include bends or dismantling joints to minimise dismantling of adjacent pipe work.

Minimum L10h bearing life shall be 50,000 hrs

3.1.14 Ram / Plunger Pumps (Reciprocating Pumps)

Pumps shall be designed for easy dismantling with separate castings for the body and stuffing box, permitting the removal of wearing parts such as pistons, connecting rods and cylinder liners, without disturbing the pump body, chambers or manifold.

All the pump passages shall be capable of passing solids up to at least 75 mm diameter.

For oil lubricated bearings, the reservoir of oil attached to each pump, from which oil is pumped to the eccentric bearings, shall be fitted with a contents gauge with contacts arranged in conjunction with the pump starter such that the pump is prevented from operating when there is insufficient lubricant in the reservoir.

3.1.15 Submersible Borehole Pumping Equipment

The impeller shall be fabricated from stainless steel or bronze of suitable grade for the nature of the water being pumped. Plastic impellers / casings will not be accepted. The pump shaft and wear ring shall be fabricated from stainless steel. Mechanical seals shall be employed with faces of tungsten carbide or ceramic. Shaft bearings shall be sealed and lubricated for life.

Inlet strainers employing 12 mm diameter holes shall be provided unless otherwise specified.

Each borehole pump shall be fitted with a mushroom type non-return valve bolted directly to the pump. The mushroom shall be drilled with a 6 mm bypass to allow draining of the rising main.

3.1.16 End Suction Water Pumps

End suction pumps with back-pull-out facility shall combine the pump and drive motor as a single compact unit. The pump shall be a single stage type directly coupled to its drive motor through a spacer coupling. The unit shall be mounted on a robust, combined base plate. The back pull-out facility shall permit removal of the shaft with its bearing housing, back cover, shaft seals and impeller in a single assembly without disturbing the suction and delivery pipework or drive motor. The back plate shall be fitted with jacking screws to enable it to be eased out of the pump casing. The positioning of the support foot, if required, on horizontal pumps for the bearing housing and bolted connections to the volute casing shall positively locate the pump rotor assembly so that on reassembly the spacer and pump shaft couplings are truly aligned.

The volute casing shall be supported on integral feet to eliminate distortion. Replaceable wear rings shall be fitted to all volute castings. Replaceable back cover wear rings shall be fitted if the impeller is fitted with hydraulic balance holes. Suction and delivery flanges shall be provided with tappings for pressure gauge connections. Air release and drain tappings shall be provided on the volute casing.

Impellers shall be overhung, single entry and fully shrouded and fitted with replaceable wear rings, including back rings if the impeller is provided with hydraulic balance holes. Alternatively rear balance vanes may be fitted. Impellers shall be secured to shafts through shaft keys and shaft nuts, the nuts being threaded to the opposite hand to the direction of rotation. The shaft nut shall be secured to the shaft by a locking device.

Bearings may be oil or grease lubricated and shall be capable of accepting the full unbalanced thrust. Bearing oil or grease seals shall provide adequate protection against bearing contamination.

Shaft seals shall be cartridge type mechanical seals.

Couplings shall be flexible spacer type on horizontal pumps.

3.1.17 Hydro-pneumatic Booster sets

Hydro-pneumatic booster sets shall comprise a hydraulic accumulator and pump sets all mounted on a skid.

The hydraulic accumulator shall be of steel incorporating a diaphragm suitable for potable water, inspection hatch, inlet air self-sealing charge valve and pressure gauge to BS 1780. As an alternative, on large sets, the contractor may propose permanently installed air compressors with suitable filtration and oil removal to maintain air pressure within the accumulator.

The accumulator shall be constructed, certified and marked in accordance with Statutory Pressure Vessel Regulations and PD 5500 or ASME VIII.

Pumps shall a cast iron casing with stainless steel impellers and shafts. Pumps shall be fitted with mechanical seals.

Pipework shall be of galvanised steel to BS 1387, fusion bonded epoxy coated steel, high performance polyethylene (HPPE), ductile iron or stainless steel. Suction and delivery isolating valves and pump delivery non-return valves shall be fitted together with a delivery pressure gauge to BS 1780.

Pumps shall be controlled by pressure switches arranged to start and stop the units on falling and rising pressure. At least two pumps shall be provided, arranged on a duty/assist basis.

Where installed in sewage pumping stations or treatment works and used in conjunction with a header tank feeding from a potable water supply, the tank shall incorporate a double check valve and an inlet ball valve arrangement.

Header tanks shall be manufactured from approved non-toxic materials with a removable lid, drain valve, overflow, inlet ball valve and level control bosses.

As an alternative to a hydro-pneumatic set, the contractor may propose a variable speed pump set with integral or remote mounted inverters. The surge vessel shall be of steel incorporating a diaphragm suitable for potable water, inspection hatch, inlet air self-sealing charge valve and pressure gauge to BS 1780.

3.1.18 Screw type impeller Pumps

Dry well screw centrifugal pumps shall be specifically designed to pump raw unscreened sewage, bio solids/activated-flocculated sludge up to 8% consistency, or other media containing solids and/or rags and other fibrous materials without clogging.

The pumps shall be designed for continuous operation and will be operated continuously under normal service. To minimize operation power costs, the

hydraulic efficiencies listed for each pump are the minimum acceptable, and must be guaranteed by the manufacturer.

The single passage screw centrifugal impeller shall have proven ability to handle typical sewage solids as well as rags and long fibrous materials without clogging.

Pump size of 50mm & 80mm connections - free passage for non-compressible solids shall be minimum 50mm

Pump size of 100mm to 150mm connections - subject to its proven success of pumping raw unscreened sewage, and or sludge, a range of impellers having free passage for non-compressible solids of 65 to 115mm

Pump sizes above 150mm connections - Free passage for non-compressible solids shall be minimum 100mm, with generally larger free passage for larger bore pump design such that a 500mm bore pump would have 230mm free passage.

The pumps selected for sludge applications shall be capable of operation at high consistency, with up to at least 8% DS, without any significant drop or collapse from its standard water performance curve.

The screw centrifugal pump impeller shall be designed such that it is able to pump activated / biological sludge without damage to the delicate & costly flocculants.

Rotational speed shall not exceed 1450 RPM.

The basic design shall be a single-passage, clog-free pump, utilizing a screw-centrifugal impeller. The impellers shall comprise a single vane, with a large open passage. The overall pump design shall combine high efficiency, low required NPSH, a large solid passage, and the ability to handle rags or other fibrous material without blocking.

Suction and discharge flanges shall be drilled to meet DIN bolting.

The pump volute, back plate and suction piece and impeller shall be of stainless steel or optional Duplex stainless steel for severe corrosion applications.

3.2 Air Blowers & Compressors

3.2.01 General

Pipe work air flow velocity shall not exceed 10m/sec. The pipework system shall have a horizontal fall of not less than 1 in 50 in the direction of air flow and incorporate drainage points at distances of not less than 30m. Drainage points shall comprise equal tees with a down-pointing leg fitted, preferably, where changes of

direction occur. Branch take-offs shall be from the top of the main and the lowest point of any falling pipes shall be drained.

Exposed pipework shall be insulated for personnel protection where surface temperatures exceed 70 degrees Celsius...

All moving parts, where accessible to operational personnel, shall be protected and suitably guarded in accordance with BS 5304:1988. All guards shall be designed to facilitate easy removal.

Units shall have anti-vibration mountings and be statically and dynamically balanced and run free from vibration. The critical speed of the rotor shall be above the operational running speeds.

Where noise levels generated by the blower or compressor exceed 85dB(A) at 1 metre or other noise limitations apply, they shall be installed in an acoustic enclosure having an outer skin of mild steel, or GRP, and an inner skin of perforated steel. Between the outer and inner skins shall be a filling of mineral wool or similar with a thin film of plastic between the mineral wool and the perforated sheet to preclude dirt and grease. A neoprene rubber strip shall be used to seal the lower edge of the enclosure.

3.2.02 Air blowers

3.2.02.1 Centrifugal Blowers

Blower sets shall comprise of single stage centrifugal air blowers with modulating powered inlet and outlet guide vanes, gearbox, lubrication system, electric drive motor, and suction and discharge flexible stainless steel connection compensators, all mounted on a common base plate. The sets shall be installed on flexible machine mounts.

The volume flow rate from the blowers shall be modulated control on the inlet and outlet guide vanes which shall be capable of varying the delivery rate down to 45% of the rated output without causing the blower to go into surge when operating either singly or in parallel. A high operating efficiency shall be maintained throughout the flow range.

Materials and equipments of construction shall give a design running life of at least 100,000 hours before major maintenance is necessary.

The impeller shall be statically balanced and the whole rotor shall be dynamically balanced. The first responsive critical speed of the rotating assembly shall be at least 10% above the maximum operating speed.

The gearboxes shall be of the parallel shaft high speed helical type . The gears shall have a minimum AGMA service factor of 1.5. A labyrinth oil seal shall be fitted to

each shaft to prevent oil seepage from the casing under operating and static conditions. The seals shall be designed to ensure there is no contamination of the process air.

Each gearbox shall be fitted with an oil level sight glass and an drain plug which shall be readily accessible in operation.

The base plate shall be provided with lifting points to allow the complete set to be handled using chain slings.

Instrumentation for the safety monitoring of air blowers shall include oil temperature, oil level, air temperature at inlet and outlet from the blower, outlet air pressure, surge conditions, bearing temperature and vibration and motor running current. The instruments shall provide signals for the shutting down of air blowers if unsafe conditions arise and for visual indication of the fault. Additionally, the contractor shall provide all necessary instrumentation for measuring the airflow from each blower.

Each blower shall be equipped with an inlet air filter, automatic unloading device, pressure relief valve, pressure switch and under load (no flow) detection device to trip the blower in case of drive/flow failure.

Each blower shall be performance tested at the manufacturer's works, using the control motors, to BS ISO 1217:1996. Air flow measurement for these tests shall be carried out in accordance with BS 1042. Blower casings shall be works hydro-statically tested to 1.5 times the maximum working pressure.

3.2.02.2 Positive Displacement Blowers

The blowers shall be complete with all ancillary equipment which may be required to enable the units to operate correctly.

Blowers shall be air-cooled and of the double rotor positive displacement rotary type with cast iron casings delivering oil-free air.

Each blower shall be complete with an automatic unloading device, dead-weight pressure relief valve, spring type pressure relief valve, pressure gauge, pressure switch and non return valve of the wafer or nozzle ring check pattern.

The blower speed shall not exceed 70% of the maximum designed speed or 2300 rpm whichever is the lower.

Each blower shall have an under load detection relay or other similar device to trip the blower in the event of a drive or flow failure.

The blower casing shall be high-grade cast iron adequately ribbed to assist cooling and avoid distortion. The rotors shall be spheroidal graphite iron with integral

shafting. Timing gears shall be of nickel cast iron positively keyed to the rotor shafts, they shall be accurately ground with close clearances to prevent interference between rotors.

The blower shall be fitted with an oil lubrication system for the bearings and timing gears. The blower shall be fitted with mechanical seals to prevent the ingress of oil into the rotor chamber.

The lubrication system shall include filling and drain plugs and oil level indicators visible from outside the acoustic cover.

The drive between the blower and motor shall be of the V- belt or flat toothed belt type and of approved design.

The complete blower assembly shall be mounted on steel section frame which shall incorporate a blower mounting plate, motor adjustment slides and guard support brackets; the frame is to be supported on anti vibration mounts.

An inlet silencer complete with replaceable filter element shall be fitted to each blower; the silencer shall be fitted with a visual indicator to warn of filter blockage.

Outlet silencer shall be fitted to maintain noise levels as low as possible. A flexible coupling shall be fitted to prevent vibration transmission to the air supply system.

Silencers to be of the reactive type, absorptive type silencers will not be permitted.

Components likely to wear in the course of normal operation shall be capable of replacement with readily available replacement components.

3.2.03 Compressors

3.2.03.1 General

The design and installation of the compressed air system shall be in accordance with the requirements of the British Compressed Air Society's Code of Practice and the Pressure Systems and Transportable Gas Containers Regulations 1989.

Compressors shall be rated to achieve the duty at optimum efficiency and may be selected from one of the following types unless otherwise specified in the particular specifications:-

(a) Reciprocating Single Stage

(b) Reciprocating Multi Stage

(c) Rotary Screw

3.2.03.2 Reciprocating Compressors

Reciprocating Single Stage Compressors shall be of inherently oil free design. The compressor shall be of cast iron construction with aluminium cylinder heads and shall be air cooled. The unit, complete with electric motor, shall be mounted on a rigid bedplate incorporating anti vibration mountings. The drive arrangement shall be belt or shaft driven and shall be fully guarded. A suitable means of achieving alignment shall be provided and where appropriate flexible couplings shall be used.

Reciprocating Multi-Stage Compressors shall be as above but incorporate interstage cooling and be of the short stroke design for low piston speeds.

Both single and multistage units shall be provided with the following:-

(a) Low oil level cut out switch.

(b) Crank case oil sight glass.

(c) Air inlet filter.

(d) Silencer complete with pressure gauge and low pressure cut out (filter blockage protection).

(e) Pressure gauge tappings after each stage for compressors up to 15kW, and gauges and safety valves on compressors over 15kW.

(f) Oil pressure indicator on compressors over 100kW.

(g) Final air temperature indicator on compressors over 100kW.

(h) Unloader valve unit.

(i) Air dryer system (Dehumidifier) where dry air is required.

3.2.03.3 Rotary Compressors

Rotary Screw Compressors shall be of the inherently oil free design and shall be either the single stage or multi-stage type depending on the duty.

The separate stages shall be enclosed in individual housings, the male rotor being gearbox driven whilst the female rotor is driven via a timing gear.

The rotor shafts shall be supported by precision made ball and roller bearings

Lubrication to the driving gear, bearings and timing gear shall be via an oil pump driven by the main shaft. The lubrication system shall be complete with oil filter and cooler, pressure gauge and fail-safe pressure switch.

On multi stage units air cooling shall be undertaken by an intercooler.

The compressor shall be motor driven via a flexible coupling and gearbox common to both stages. A suitable means of alignment shall be provided.

The complete compressor set i.e. compressor, motor, gearbox and associated cooling equipment shall be supplied on a rigid bed plate suitable for floor mounting via anti vibration mountings.

3.2.03.4 After Cooler

All types of compressor shall be fitted with an after cooler. These shall be of the air cooled type comprising an air to air heat exchanger. The after cooler shall cool the process air to a temperature of 10 ^{o}C above ambient. The after cooler shall be fitted with an automatic condensation drain which shall be provided with a manual bypass.

Delivery lines from the Compressor Sets shall be fitted with the following equipment:-

a. Oil trap/filter prior to entry into the air receiver. The filter shall be fitted with an auto drain and manual by pass.

b. Adjustable safety valve (lockable).

c. A solenoid valve for unloading (dependant upon compressor size) for applications where the compressor is directly coupled to a surge vessel.

d. A non return valve.

e. (e)A high efficiency coalescing oil filter (0.001 micron filtration).

3.2.03.5 Air Receivers

Unless otherwise stated, one air receiver shall be provided, normally being online, but with the capacity to be isolated from the system.

These shall be manufactured from fusion welded steel and shall comply with BS 5169 or equivalent for the appropriate pressure class.

Air receivers greater than 1000 litres capacity shall be designed and manufactured in accordance with PD 5500 or equivalent.

Each integral air receiver shall have sufficient capacity to damp out air pulses from the compressor and to prevent pressure drops on process valve actuations.

The air receivers shall be connected such that the duty compressor delivers into either or, if two air receivers are specified, both of the air receivers. Diaphragm

isolation valves shall be provided for isolating either of the receivers from the system.

The air receivers shall be suitable for floor mounting and shall be supplied with two inspection ports. The inspection ports shall be of the elliptical type and pressure sealed.

3.3 Cutting Devices

3.3.1 General

Cutting devices can be utilised on raw sewage, screenings or sewage sludge.

The general construction, including the bearings, shall be designed to withstand regular shock loadings. Higher speed units shall have mechanical protection against damage caused by impeller jamming.

3.3.2 Comminutors, conditioners and macerator pumps

Shall be capable of reducing matter to a size 5mm x 15mm.

Comminutor/macerator motors and inertia mass shall be sufficiently sized to ensure that heavier materials do not normally stall the drive. Electrical overloads shall adequately protect the motor but ensure that abnormally high torques can be delivered before trip occurs.

Attached centrifugal pumps shall have open type torque flow impellers. Progressive cavity pumps may also be utilised.

Maximum speeds shall be 1450 rpm.

The cutting device shall be of hardened chrome molybdenum steel or tungsten carbide tipped against a hard steel cutting plate. The wearing component shall be easy to replace.

Comminutors shall be easy to inspect and repair. In shallow channels, this will not involve a davit lifting arrangement.

3.3.3 Grinders

Grinders shall have counter rotating cutting discs capable of shredding most materials including sludge, rags and thin gauge metal.

Cutter shafts shall be housed in a strong cast iron casing and shall be cantilevered to prevent winding of rags. Ready access to remove caught debris shall be provided.

The speed of the cutters shall be limited to approximately 70 rpm.

The cutters shall be of hardened chrome molybdenum steel.

A control device shall be employed whereby the drive is reversed on an initial and subsequent jam, but that the unit trips and alarms when jams recur immediately.

Where the grinder output is to a companion pump, a common motor can be utilised.

Appendix A

Sludge Pump Selection Matrix

SLUDGE PUMP SELECTION MATRIX

Fitness for purpose procedure

1. Identify Sludge Type
2. Select Pump for "Fitness for Purpose". If 'X' in box move right to first 'Y'
3. Follow column down to required duty. If 'X' in box move right to first 'Y'
4. Follow column up to Grit/Rags and repeat procedure until no 'X's appear in selected column

PARAMETER		PUMP TYPE					
Application		Centrifugal	Diaphragm	Mechanical Ram Pump	Progressive Cavity	Peristaltic	Hydraulic Ram
Grit in medium		Y	Y	Y	X	X	Y
Rag in medium		Y	X	Y	X	X	Y
Sludge Type	Primary/Primary Humus 1 - 8 % DS	X	Y	Y	Y	Y	Y
	Humus 1 - 6 % DS	Y	Y	Y	Y	Y	Y
	Primary/ASP 1 - 6 % DS	Y	Y	Y	Y	Y	Y
	Thickened 5 - 15 % DS	X	Y	Y	Y	X	Y
	Cake 15 - 35 % DS	X	X	Y	X	X	Y
	RAS 0.5 - 1.5 % DS	Y	Y	Y	Y	Y	Y
	Digested 2 - 6 % DS	X	Y	Y	Y	Y	Y
Flow < 25 m3/hr Head < 2 Bar		Y	Y	Y	Y	Y	Y
Flow < 25 m3/hr Head 2 - 8 Bar		Y	Y	Y	Y	Y	Y
Flow < 25 m3/hr Head 8 - 24 Bar		X	Y	X	Y	X	Y
Flow 25 - 100 m3/hr Head < 2 Bar		Y	Y	Y	Y	Y	Y
Flow 25 - 100 m3/hr Head 2 - 8 Bar		Y	Y	Y	Y	Y	Y
Flow 25 - 100 m3/hr Head 8 - 24 Bar		X	X	X	Y	X	Y
Flow < 450 m3/hr Head < 2 Bar		Y	X	X	Y	X	Y
Flow < 450 m3/hr Head 2 - 8 Bar		Y	X	X	Y	X	Y

Flow < 450 m3/hr Head 8 - 24 Bar		X	X	X	X	X	Y

Appendix B

Dosing Pump Selection Matrix

DOSING PUMP SELECTION MATRIX

Fitness for purpose procedure

1. Identify sludge type
2. Select Pump for "Fitness for Purpose", If 'X' in box move right to first 'Y'
3. Follow column down to required duty, If 'X' move right to first 'Y'
4. Follow column up to Grit/Rags and reprat procedure untol no 'X's appear in selected column.

Parameter		Pump Type					
Application		Centrifugal	Diaphragm	Mechanical Ram Pump	Progressive Cavity	Peristaltic	Hydraulic Ram
Medium Type	Lime Slurry						
	0.5%5%ds						
Low Flow Low Head		X	Y	Y	Y	X	
Low Flow Med Head		X	X	Y	Y	Y	
Low Flow Hi Head		X	X	Y	Y	Y	

Appendix C

Clean Water Pump Selection Matrix

CLEAN WATER PUMP SELECTION MATRIX

Fitness for purpose procedure

1. Identify sludge type
2. Select Pump for "Fitness for Purpose", If 'X' in box move right to first 'Y'
3. Follow column down to required duty, If 'X' move right to first 'Y'
4. Follow column up to Grit/Rags and reprat procedure untol no 'X's appear in selected column.

Parameter		**Pump Type**					
Application		Centrifugal	Diaphragm	Mechanical Ram Pump	Progressive Cavity	Peristaltic	Hydraulic Ram
Medium Type	Raw Water	Y	X	X	X	X	X
	Treated Water	Y	X	X	Y	X	X
Low Flow Low Head		Y	X	X	X	X	X
Low Flow Med Head		Y	X	X	Y	X	X
Low Flow Hi Head		Y	X	X	Y	X	X
Med Flow Low Head		Y	X	X	X	X	X
Med Flow Med Head		Y	X	X	X	X	X
Med Flow Hi Head		Y	X	X	X	X	X
Hi Flow Low Head		Y	X	X	X	X	X
Hi Flow Med Head		Y	X	X	X	X	X
Hi Flow Hi Head		Y	X	X	X	X	X