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PARTICULAR SPECIFICATION

M16: MECHANICAL CONVEYOR EQUIPMENT

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PARTICULAR SPECIFICATION M16: MECHANICAL CONVEYOR EQUIPMENT

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M16.1 SCOPE

This specification covers the detailed design criteria, manufacture, supply, installation, test and commissioning of mechanical belt conveyor systems for the conveyance processed sludge at a waste water treatment works.

M16.2 INTERPRETATIONS

M16.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African Bureau of Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee

M16.2.2 Standards

All design standards for the conveyor systems shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 1168, 1313 and 1173	: Conveyor equipment
ISO 5048	: Design of Conveyors
ISO 5048	: Continuous mechanical handling equipment, Belt conveyors with carrying idlers, Calculations of operating power and tensile forces
SABS 400: 1990	: National Building Regulations
BS 5304: 1988	: Code of practice for safeguarding of machinery
SABS 044 Part III to IV: 1993	: Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	: Dimensions of ball bearings, cylindrical and spherical roller bearings
SIS 05 59 00	: Pictorial Surface Preparation Standards for Painting Steel Surface

M16.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M16.3 DESIGN OF CONVEYOR EQUIPMENT

M16.3.1 General Design Parameters

Equipment shall be designed:

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- To ensure safe and satisfactory operation for an acceptable life expectation of 12 years under the conditions prevailing at the site.
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum.
- To facilitate inter-changeability of units and/or sub-parts throughout the contract works with regards to new equipment and equipment and/or sub-parts currently being used on the existing Johannesburg Water Sites.
- To operate without undue vibration and excessive noise. Maximum of 84dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution.
- To satisfy any specific requirement contained in the statutory codes and legislation.
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.
- As a minimum, components shall be selected with a service factor of 1.5 applied to the maximum operating power to be transmitted or otherwise as per the manufacturer's recommendations.

M16.3.2 Belt Conveyors Design of Parameters

All plant and equipment shall be designed to operate satisfactory under atmospheric, ambient and other conditions specified in the Project Specifications.

All conveyors shall be designed for a surcharge angle of 0° and a troughing angle of 35°.

Design tonnage and maximum tonnage for belt conveyors shall be for a digested sludge cake of 18 – 22 % dewatered from a belt press process. No additional percentage shall be applied to the maximum feed tonnage to obtain a maximum design tonnage.

The maximum belt speed for a conveyor system shall be 0.75 m/s. Conveyors shall be capable of starting up under full load.

Inclination of conveyors shall be such that no runback of material occurs when the belt is loaded. The maximum inclination of any conveyor will be 14°.

Where transfer points are located outside a building then the transfer point is to be covered with a steel structure with roof sheeting and side sheeting to the top 50% of the side height to facilitate maintenance.

Gearboxes shall be standardised as far as is possible. Integral holdbacks shall be provided for conveyors where required. Speed reducers shall be of the helical geared, shaft-mounted types. Gear unit ratios shall be based on 4 pole, 50Hz motors with the minimum gear unit service factors being 2.0 based on installed motor power. Thermal and mechanical service factors shall be selected such that the gearbox shall be able to operate effectively without the risk of excessive heat build-up under all operating and ambient conditions specified.

A spare gearbox for each size of gearbox used in the conveyor system installation shall be supplied for storage in the client's stores.

All conveyor equipment will comply with SANS 1173. In the design of the equipment, special consideration shall be given to the standardisation of such parts as pulleys, gearboxes, hold-backs, couplings, shafts, bearings, electric motors, etc. reducing spare equipment to a minimum.

Belt widths, belt speeds and transfer points shall be designed with particular attention to the prevention of spillage. The maximum belt loading capacity shall be 85% of theoretical loading capacity.

M16.3.3 Starting Equipment

Accelerating and braking forces shall be taken into account in the calculations of belt tensions and counterweights. Starting equipment shall be designed that the belt is not over-stressed when started under a full load.

M16.3.4 Pulleys

The diameter of driving, tail and tripper pulleys as well as pulley shafts shall be as specified in SANS 1169 and shall be calculated for belt tensions between 100 - 150% of the maximum operating working tensions.

Pulley bearings shall be of the spherical roller bearing type with a L10_h life rating of 100,000 hours. Pulleys shall be of the fabricated type, bearings and pulleys shall be standardised.

The driving and tail pulley shall be rubber lined after manufacture

M16.3.5 Idlers

Outer surfaces shall be smooth and corners chamfered. Each assembly of roll, shaft, bearings, seals, etc. shall be concentric. Rolls shall be no less than 125 mm outside diameter.

Bearings shall be high-grade anti-friction type and shall have a minimum L10_h life rating of 100,000 hours. Idler bearings shall be of the life lubricated type. The bearings shall be protected by an effective sealing arrangement.

Troughing idler assemblies shall be of the three-roll type, in accordance with SANS 1313.

Parts exposed to dirt accumulation shall be designed and constructed for self-cleaning. Idler spacing shall comply with the spacing specified in SANS 1173. Return idlers shall be subject to the same basic design principles as the troughing idlers shall also apply to impact idlers.

At the loading points, closely spaced troughing idlers shall be used. The same provisions regarding bearings, etc. applicable to troughing idlers shall apply to impact idlers.

M16.3.6 Loading and Transfer Points

Loading and transfer points shall be designed with the primary objective of reducing belt wear to a minimum and to eliminate spillage. Feed presentation from belts to equipment in parallel via trouser leg chutes will be central to the chute to avoid preferential feed to the equipment.

Feed presentation to the belt shall be central to avoid training problems. Chutes shall be designed to utilise the most suitable and economical wear resistant materials available and shall be made large enough to facilitate access for maintenance purposes.

Chute valley angles shall be a minimum of 60° from vertical.

New chutes and hoppers shall be provided with replaceable liners. All surfaces to be lined shall be covered over the full surface area that may be subject to wear.

Sideliners shall be made of not less than 4.5 mm thick VRN 500 plate. Impact liners shall be made of no less than 4.5 mm thick VRN 500 plate.

The liners shall be sized to facilitate ease of replacement and inter-changeability.

Chutes shall be provided with inspection hatches to allow for ease of inspection and block chute detection if required.

M16.3.7 Take-ups

Gravity type take-ups shall be provided on all conveyors exceeding 40m between centres of the drive and tail pulley. Take-ups for conveyors shorter than 40m shall be screw type.

M16.3.8 Walkways and Gantries

Walkways shall be open grid flooring suitably corrosion protected and shall be 750mm wide. All inclined walkways on conveyor gantries shall be of sloped construction and not stepped. All conveyors are to be supplied with only one walkway.

Where weight meters are to be installed on conveyors, a straight section of at least 6m will be allowed for the installation.

Where conveyors interface with buildings at ground level, external access to the gantry shall be allowed for without having to enter the gantry through the building.

M16.3.9 Belting

Belting shall conform to SANS 1173. All splices shall be hot vulcanised.

M16.3.10 Belt Cleaning

Scorpio type (or similar approved by the Engineer) primary and secondary scrapers shall be used for belt cleaning of all conveyors.

M16.3.11 Return Belt Ploughs

All conveyors shall be fitted with Scorpio type (or similar approved by the Engineer) belt ploughs on return belts situated at the tail end.

M16.3.12 Skirts

Skirts shall be provided at all feed points.

M16.3.13 Deck Plates

Deck plates shall be provided at head, take-up and tail terminal points, including areas where conveyors cross access roads or buildings. All deck plates shall be of mild steel construction and painted to the paint specification requirements.

M16.3.14 Protection

Suitable protection shall be provided for slippage and in the event of an obstruction causing the conveyor operation to be interrupted. The protection provided shall interrupt the operation of the conveyor.

The protection device shall be of an Intelligent Motor Protection Relay type with built in phase angle protection. As a backup device a torque overload coupling with a limit switch shall be provided. The limit switch must have at least one SPDT contact or one normally open and one normally closed contact capable of switching at least 500mA at 230 Volts AC. The contractor shall provide details of the proposed system at the time of tendering.

All conveyor equipment shall have a trip switch operated by a switch wire on both sides of the conveyor for emergency tripping. The trip wire must be operational along the full length of the conveyor.

Suitable protection shall be provided for belt tracking/alignment. The contractor shall provide details of the proposed system at the time of tendering.

It is a requirement of this specification that the above malfunction in operation be reflected on the works SCADA system.

M16.4 DESIGN SERVICE FACTORS

M16.4.1 Service Factors Specified

Where special requirements exist, these shall be stated in the individual equipment specifications/data sheets and design service factors shall exceed these values.

M16.4.2 Service Factors Unspecified

For continuous duty and heavy shock loads, service factors shall be individually considered and shall be approved. For medium duty and light shock loads, the following service factors shall apply. Consideration must also be given to the individual starting conditions in the selection of these components.

In selecting the capacity of electric motors, gears, gearboxes, power transmissions, couplings, pulleys, shafts, belts, etc., the design theoretical kilowatt ratings shall be increased by 20%.

In selecting the capacity of electric motors, couplings, shafts, vee-belts, and vee-belt drives, etc. for pumps, the designed theoretical kilowatt rating shall be increased by 25% to 50%, and for agitators (not stirrers) by 50%, to allow for possible overloading produced by pumps delivering larger quantities or at specific gravities higher than specified by the process requirement.

The factors of 25% to 50% and 50% shall be additional to the design factors used to obtain the theoretical kilowatt rating.

M16.4.3 Overload Capacities

Machinery and equipment, excluding motors, shall be designed to withstand a starting overload based on a minimum of 100% momentary overload, 50% overload allowance for 15 minutes and 25% overload allowance for periods not exceeding 2 hours. Refer to individual equipment specifications for variations.

M16.4.4 Transmission

Chain drives shall be in accordance with BS 228: 1984 – Transmission Roller Chains, Chain Wheels and Cutters.

Sufficient take-up allowance shall be provided on the motor mounting to take up two full chain pitches. Where take-up allowance is not possible due to fixed shaft centres, an adjustable chain wheel idler shall be incorporated.

All chain drives shall be adequately guarded and lubricated.

Unless otherwise specified, V-belt drives shall be standard sections and of the Space-Saver type. Belts shall be furnished in matched sets. Sheaves shall be accurately balanced and fitted with keyed 'Taper-Lock' bushings.

Drive motors shall be mounted on slide or pivoted bases allowing sufficient adjustment for correct belt tensioning according to the manufacturer's requirements. Bases shall incorporate jack screws with lock nuts. All V-belt drives shall be adequately guarded.

Gearboxes

Gearing shall be in accordance with the appropriate AGMA standards as revised. All gearing shall be machine cut to high commercial grade and shall be suitably heat treated before final machining.

Gearing not enclosed in an oil bath shall be adequately guarded and provision shall be made for safe lubrication.

Speed reduction units shall be of approved design and manufacture. Allowance for efficiency, cooling and lubrication shall conform to the manufacturer's recommendations.

Gearboxes shall be of rigid construction manufactured either from cast steel or fabricated from mild steel plate.

Gearboxes shall be dustproof and equipped with inspection covers, drain and filler plugs, breathers with suitable filters, oil level indicators or dip sticks and lifting lugs as required.

Fabricated gearboxes shall be guaranteed against distortion when in service.

Foot mounted gearboxes shall be assembled together with the prime mover on a common baseplate and accurately doweled in position. Shaft mounted gearboxes shall be mounted according to the manufacturer's recommendations.

NOTE: A spare gearbox for each size of gearbox used in the conveyor system installation shall be supplied for storage in the client's stores.

All rotating equipment shall be clearly marked with an arrow showing the direction of rotation.

Bearings

Where required by design considerations, well lubricated non-ferrous bushings and bearings may be used.

Where phosphor bronze bearings are used the quality shall be to SAE 64 or equivalent. The supplier shall be required to provide details of specification number and analysis of metals used. This requirement shall also apply to the use of white metal.

Self-lubricating graphite or compound bearings shall not be used unless specifically requested.

For heavy duty and continuous service, Plummer blocks shall be anti-friction spherical roller type with split housing rated to suite the application. All Plummer blocks shall be fully self-aligning with one fixed and one floating type for each shaft assembly. With parallel shafts, inner ring adapter sleeves may be used.

For lighter duty, 80mm diameter and less, ball bearing Plummer blocks may be used.

Unless otherwise specified, the basic rated life for all anti-friction bearings shall be 75,000 hours

(L10_n as defined by SKF).

Plummer blocks shall be mounted on accurately machined sole plates equipped with lugs and jack screws with lock nuts for proper horizontal alignment.

All Plummer blocks shall be installed such that the loads pass through the base and not the cap. Deviations from this arrangement for practical reasons shall be subject to approval and accompanied by design calculations.

Bearing housings shall be of cast steel, good quality cast iron or fabricated to specification and accurately machined where necessary. Housings shall be mounted on machined surfaces and located and fixed by permanent devices.

Design allowance shall be made for keyways and combined bending and torsion stress. Suitable fillet radii shall be provided at changes in diameter and shaft ends shall be chamfered. Changes in diameter and keyways shall not coincide.

Light duty shafting shall be hot rolled polished mild steel or cold rolled mild steel. Cold rolled shafting shall be subject to approval.

All shafts shall be metric and shall be supplied with key seats and keys or feathers in accordance with BS 4235 Part 1: 1986 unless a fastening method other than by key is used. Any such proposed fastenings shall be submitted to the responsible Engineer together with design calculations for approval.

All couplings shall be fitted with a removable guard unless the machine is already guarded in such a manner as to make a separate guard unnecessary.

Brakes shall be adequately sized for the load characteristics and heat dissipation.

M16.5 LUBRICATION

Lubricants and lubrication fittings shall be in accordance with the following standards:-

- SANS 053:1972 : Viscosity Classification of Industrial Lubricating Oils
- SANS 344:1974 : Calcium Base Lubricating Grease
- SANS 351:1974 : Sodium Base Lubricating Grease
- SANS 406:1974 : Lithium Base Lubricating Grease
- SANS 1014:1974 : Multi-Purpose Lubricating Grease
- BS 1486:1982 : Lubricating Nipples Parts 1 & 2
- BS 1399 Parts 1 to 3:1970 : Rotary Shaft Oil Seal Units

All equipment suppliers shall submit a specification of the lubrication requirements for their equipment, which shall include the following:-

- (i) Approximate quantities required for the initial fill.
- (ii) The expected rate of consumption of the lubricant and the recommended intervals for a complete change of lubricant.
- (iii) A lubrication chart indicating all lubricating points, periods for lubrication, oil and filter changes.
- (iv) A list of South African based suppliers of the recommended lubricants.

All Plummer blocks shall be sealed against the ingress of moisture or dirt by means of a double

lip seal or a Labyrinth seal.

Where wet or extremely dirty conditions occur, a flinger shall be used in addition to seals.

For vertical shafts, a flinger shall be installed above the upper bearing seal. Lubrication of equipment, such as gearboxes, compressors, etc. shall conform to the recommendation of the equipment manufacturer.

All equipment, which normally contains lubricant and is despatched without such lubricant, shall be sprayed internally with a suitable moisture inhibitor to prevent deterioration during transport and storage. All machinery and equipment shall be checked for cleanliness and lubrication prior to testing or start-up.

Any special requirements for flushing and cleaning shall be stated by the manufacturer.

Such equipment shall carry clear legible tags indicating that there is no lubricant contained therein.

Gearing and chain drives shall have fully enclosed oil bath lubrication except where a low peripheral velocity requires grease lubrication. Where the peripheral velocity of gearing exceeds 750 m/min, forced feed lubrication shall be provided.

All lubrication points shall be easily accessible from the normal maintenance/operating zones of the equipment. If necessary, lubrication points shall be extended by means of pipes or tubing to a location that is both convenient and safe for access during normal equipment operation.

M16.6

BASEPLATES

Baseplates shall be designed to prevent undue deflection or failure under any conditions of loading likely to be encountered.

Baseplates shall be rigidly constructed, generally of cast steel or fabricated steel. For light duty, cast iron bases may be used.

Where practical, the prime mover and the gears, bearings, or other equipment shall be mounted on a common base plate.

Mounting pads and base plate feet shall be machined true and parallel. Allowance shall be made on the prime mover mounting pad for 5 mm maximum and 1 mm minimum shimming.

Where baseplates are fabricated they must be stress relieved before machining.

Baseplates shall incorporate jack screws with lock nuts to assist with aligning of the prime mover in relation to the gearbox, bearings or other equipment.

M16.7

PLATEWORK

Where bins, chutes, liners and skirts are supplied as an integral part of mechanical equipment they shall be designed such that:-

- (a) They allow for the fast, smooth flow of material and avoid abrupt changes of direction which invite material build-up and subsequent plugging.
- (b) They have a minimum of throat constrictions.
- (c) They are firmly supported, manufactured from a minimum of 6 mm plate to SANS 1431 Gr. 300 WA and are suitably stiffened and supported to deal with loads and forces

imposed on them.

- (d) Their valley angles are conservative and suitable for the materials handled.
- (e) Falling material does not impact directly on sensitive receiving equipment but rather on the sloping bottom of chutes.
- (f) Chutes and hoppers shall be provided with bolted flange connections in order to simplify installation and maintenance.
- (g) All nozzles to be fabricated from scheduled piping, wall thickness to match plate work thickness. Flanges will be specified on the relative data sheets.
- (h) All plate work and chutes to be trial assembled and match marked by the fabricator before delivery to site.
- (i) Bins, chutes, etc. and support structure (where required) shall be designed for a maximum static load when all full of mineral sand or slurry at a design bulk density as specified. Subassemblies or components shall be fitted with lifting lugs designed with adequate safety factors to lift the subassembly or components. Travelling members to be fitted (where required) to avoid distortion. Fabricator to supply spreader bars for components requiring such.
- (j) Where equipment such as scrapers, rappers and squeezers, spray units, etc. are housed within the chutes, they must be able to be removed without disturbing the main assembly.
- (k) Where material is in contact with the chutes, suitable liner plates shall be installed which shall be fastened by means of nib head countersunk bolts and waterproofed where necessary. Such liner plates shall be designed to allow for interchange ability and not to exceed 30 kg in mass.
- (l) Equipment subject to abrasive slurry particle contact shall be protected against such abrasive materials by a minimum 6 mm thick natural rubber lining. All lining is to be returned around flange faces for sealing. Rubber lining shall be done in accordance with BS 6375-5: 1985 and SANS 1198: 1978.
- (m) The maximum deflection of any plate shall be less than 1 mm in 300 mm.

UNLESS OTHERWISE STATED ON THE DRAWING, LINER PLATES SHALL BE ARRANGED IN A BRICK PATTERN WITH A GAP OF NOT MORE THAN ONE LINERPLATE THICKNESS OR 10 mm (WHICHEVER IS THE LEAST) BETWEEN ADJACENT LINERS

M16.8

DUCTING AND SHEET METALWORK (DUST COLLECTION AND VENTILATION)

Ducting, flanges, gates, etc. shall conform to details shown by the Industrial Ventilation Manual of Recommended Practice issued by the American Conference of Governmental Industrial Hygienists.

Ducting shall be checked after fabrication to ensure that:-

- No pin-holes or slag inclusions which would cause leaks during service are present in any welds.
- Inside diameters are to drawing, and ducts are concentric within 5 mm on diameter.
- Supports shall be designed and spaced so that sagging does not occur, allowing for a normal dust load, and shall be structurally adequate allowing for a dust filled plugged duct.
- After erection of ducting and the installation of dust extraction units, the complete system

shall be tested, balanced and blast gates locked or tack-welded in place.

- All ducting and bends shall be manufactured from mild steel with a minimum thickness of 3 mm.
- All ducting shall have flanges welded to each end of each piece; such flanges shall be of a suitable thickness for the diameter but shall not be less than 3 mm.
- All flanged connections shall be complete with matching gaskets made from material suitable for the needs of the process.

M16.9 WIRE ROPE, CHAINS AND FITTINGS

All ropes, whether fixed suspension or for general use, shall comply with all relevant Acts and Statutory Regulations.

Hoist ropes and fittings shall comply with the regulations of the Mines and Works Act and the Machinery and Occupational Safety Act of the Republic of South Africa.

Rope fittings shall be securely attached to the ropes, preferably with terminal splicing standard spelter fittings or approved swaged fittings. All rope slings shall be tested to twice the required working strength. Spelter fittings shall not be used for high temperature applications. Where rope clips are specified, a minimum of three rope clips and a thimble shall be correctly fitted to make the connection.

All lifting tackle shall be supplied with test certificates.

Rope slings for general use shall be fitted with a metal tag indicating the safe working load.

Sockets, thimbles, rigging screws, stretching screws, eyebolts, etc., shall have a safe working load of no less than that for the attached rope or chain. Wire rope and fittings that are a stationary part of a machine, and fixed guys shall be galvanized.

Chains shall comply with all relevant Acts and Statutory Regulations and shall be stamped indicating the safe working load.

M16.10 FASTENERS

When bolting onto parallel surfaces, all nuts shall be fitted with plain parallel washers except where the machinery is subject to vibration or movement. Then, springs washers, nylon insert locknuts or tack welding shall be used as indicated by the design. Adjustable nuts (e.g. bearing take-up), castellated nuts with split cotter pins shall be used. For thread diameters of 10 mm and under, the use of tab washers is permitted.

High strength friction grip bolts shall be installed in accordance with:-

- SANS 094:1982 Bolted Friction-Grip Joints
- BS 3294 Part 1:1960 Structural Steelwork (Metric Units)

Precision bolts and nuts shall be supplied in accordance with:-

- SANS 136:1985 ISO Metric Precision Hexagon-Head Bolts, Screws and Nuts (Metric Units)
- SANS 646:1962 Precision Bolts, Screws and Nuts

Black bolts and nuts shall be supplied in accordance with:-

- SANS 135:1985 ISO Metric Black Bolts, Screws and Nuts Hexagon and Square (Metric

Units)

- SANS 1143:1977 Mushroom and Countersunk Head Bolts and Nuts

Washers shall be supplied in accordance with SANS 1149 – Flat and Tapered Steel Washers.

Black bolts shall be installed in accordance with the following assembly requirements:-

- (a) All bolt heads and nuts shall make contact, bearing on parallel plan surfaces perpendicular to the bolt axis.
- (b) A tapered washer shall be correctly positioned under the bolt head or the nut whenever the surfaces contacted are not parallel and perpendicular to the bolt axis. It shall be used against the sloping surface.
- (c) A flat washer or a tapered washer shall be used under the bolt head or nut, whichever is to be rotated during tightening operations. Washers shall be of adequate size and thickness to prevent their distortion, for any reason, during tightening.
- (d) After assembly and proper tightening, bolts shall project through nuts for a minimum distance of three (3) full threads.

When assembled, all HSFG bolted joint surfaces shall be free of dirt, loose scale, burrs and other defects that would prevent solid seating of the parts. All contact surfaces shall be free of oil, paint and lacquer or galvanising.

All HSFG bolts shall be torqued using load-indicating washers of an approved type to ensure correct tension is achieved.

Plate liners, unless otherwise specified, shall be fitted with nib-headed countersunk bolts, and spring washers shall be used under the nuts.

M16.11 OPERATION AND MAINTENANCE

Operation and maintenance of mechanical equipment shall be carried out strictly in accordance with the Equipment Manufacturer's recommendations.

The Equipment Manufacturer shall supply Operation and Maintenance instructions which shall include full details and recommended frequencies of periodic maintenance checks, adjustments, running clearances and lubrication requirements.

M16.12 PLANT LAYOUT

The following criteria shall apply for plant layouts:-

Buildings and conveyor transfer towers shall be positioned to make use of the natural slope of the contours at the site where possible, i.e. to minimise building heights and conveyor lifts.

Major mechanical equipment shall be positioned to facilitate removal with overhead cranes in the event of breakdown or maintenance. For smaller equipment, or where equipment cannot be reached by cranes, due to the nature of the plant layout, hoists and crawl beams will be used for maintenance purposes.

All sump pumps shall be suitably guarded for personal safety, as well as protection against the ingress of large objects.

The layout of the plant shall allow sufficient access for personnel engaged in operational and

maintenance duties.

M16.12.1 Platforms and walkways

Platforms and walkways shall be provided wherever access is required for regular inspection, lubrication or operation of machinery or equipment.

Walkways shall be clear 600 mm wide as a minimum.

Access to all valves, instruments and equipment lubrication points will be provided either from the ground floor or from a platform.

A minimum clearance of 2100mm shall be provided under equipment and steelwork.

Stairways shall be provided rather than ladders except in extreme cases where space is not available or usage will be very infrequent.

Stairway slope shall be between 38° and 42°, maximum slope.

A walkway will be provided along one side of each belt conveyor.

Access ladders shall be provided to all crane bridges.

Vendors to specify maintenance clearance requirements for equipment supplied, these clearances to be incorporated into layouts.

M16.13 **ROTATING EQUIPMENT**

The direction of rotation of all rotating non-reversing equipment will be clearly and indelibly marked on the casing or nameplate.

M16.14 **STAIRWAYS AND PLATFORMS**

Stairways, platforms, access ladders and landings shall be provided as necessary and shall conform to relevant Building Regulations, or International Design Standard. Stairway slope shall be between 38° and 42° maximum.

M16.15 **HANDRAILS**

Handrails shall be provided around all permanent openings, the edges of elevated platforms and access ways abutting edges to all internal side wall sheeting and walls, and to each stairway stringer and where required for safety.

M16.16 **EQUIPMENT ERECTION**

All equipment shall be erected in accordance with the requirements of the Mechanical Erection Specification, and in accordance with Equipment Manufacturer's Installation Instructions.

M16.17 **EQUIPMENT NAME PLATES**

All equipment shall have permanent nameplates of material suitable for corrosive conditions on which the equipment number and description shall be clearly marked. This will facilitate equipment identification during construction and commissioning.

M16.18 OVERHEAD CRANES, LIFTING BEAMS AND HOISTS

Overhead cranes shall be sized for maintenance duties as apposed to installation duties. The overhead cranes will be sized for the heaviest regular maintenance lift required.

Lifting beams, hoists and cranes shall be provided for ease of servicing and removal of equipment. Adequate space shall be provided for rigging, removal and set down. Lifting beams and crane rails shall be designed to the relevant standards and test certificates shall be provided. Beams shall be stamped with the appropriate SWL. Lifting beams shall be equipped with a trolley from which to attach the hoists.

M16.19 SAFETY

M16.19.1 General

All mechanical designs shall ensure that the relevant regulatory and statutory requirements are met.

M16.19.2 Guards

All rotating parts that are accessible shall be guarded. Shield guards or guard railing shall be provided at all belts, pulleys, gears, or moving parts.

Handrails, toe boards, and nonslip surfaces shall be provided on all elevated platforms, walkways, stairways and ramps.

All nip points shall be adequately guarded to prevent injuries

M16.19.3 Signs

Signs shall be provided to alert all personnel of the need for protective clothing such as steel capped boots, hard hats, and safety glasses.

Signs shall be provided where a specific exists, such as live conductors, high noise levels, low head clearance, trip hazards, hot surface prevails.

M16.19.4 Clothing

Special footwear, masks and clothing for areas with high dust levels or surface area contamination shall be used.

Non-slip footwear, gloves, helmets, face protection, leggings and other protective equipment, as necessary, for work near high temperature materials shall be used.

Where there is a risk of flying chips or sparks, or where intense light is generated, eye protection shall be used.

Protective clothing and goggles shall be used in areas where highly corrosive materials are handled.

Emergency eyewash stations and safety showers shall be installed as required.

The mechanical design shall ensure that priority is given to all project safety and ergonomic aspects, including plant layout, constructability, maintainability and operability.

M16.20 SPARES AND TOOLS

The Tenderer must submit on the appropriate schedule a priced list of spare parts which nit is recommended should be kept by the water treatment plant for maintenance of the plant. Spares which the Management decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept available for not less than 15 years.

Tenderers must submit a provisional price (where applicable) for a complete set of spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied. All spanners, keys and tools shall be new and unused.

M16.21 PROOF OF MAINTENANCE

The period of maintenance will extend over a period of 12 months calculated from the Completion as defined in the Appendix. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Engineer reserves the right to extend the Period of Maintenance in respect of such portion or all of the plant and equipment for a further period of not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification

M16.22 METAL PREPARATION AND CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection

M16.23 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01: Colour Codes.

M16.24 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

QM shall be categorised as 'critical and major' for this section of the Project.

M16.24.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

The successful Tenderer shall submit a QCP covering all aspects of the manufacturing process, indicating held points to allow the Engineer opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M16.24.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be afforded every opportunity to certain stages of completion of the installation to ascertain compliance with the Specifications and to witness the Contractor's site activities at the Engineer's discretion.

M16.25 SYSTEM PERFORMANCE

M16.25.1 Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

In the case of gearboxes, they shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection

M16.25.2 Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

M16.25.3 After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional
- Ensure that all transfer points are operating satisfactory with no spillage.

M16.25.4 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing

M16.26 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, civil preparation, coring and grouting, etc. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the conveyor equipment required.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.