

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
M05: MECHANICAL WASTEWATER AND
SLUDGE MIXING EQUIPMENT



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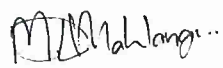


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PARTICULAR SPECIFICATION: M05: MECHANICAL WASTEWATER AND SLUDGE MIXING EQUIPMENT

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M05.1 SCOPE

This specification covers the detailed design parameters, manufacture, off-loading on site, supply, installation, test and commissioning of mechanical mixing equipment for anaerobic and anoxic compartments within a biological reactor at a wastewater treatment works. The Specification shall be read in conjunction with Project Specification and other relevant Particular Specification.

M05.1.1 Interpretations

This specification shall be interpreted as follows:

- For the Employer design components, it shall be regarded as a specification.
- For the Contractor design components obligations, it shall be regarded as an Employer's requirements.

M05.1.2 Definitions

For the purposes of this Specification the following definitions shall apply:-

- (a) **"Manufacture"** includes, as applicable, the purchase of materials or goods, fabrication and assembly, any specified corrosion protection measures and any off-site inspection or testing of materials or parts.
- (b) **"Supply"** includes, as applicable, the purchase of materials or goods, manufacture and fabrication, any specified corrosion protection measures and all required off-site inspection or testing.
- (c) **"Installation"** includes, as applicable, all handling and transport from storage, erection and aligning of Works.
- (d) **"Factory Acceptance Test (FAT)"** shall refer to all tests done on Plant or Plant items at the factory to ensure its functionality

M05.1.3 Abbreviations

For the purpose of this Specification the following abbreviation shall apply:-

°C	: Temperature in degrees Celsius
A	: Current
AC	: Alternating Current
AGMA	: American Gear Manufactures Association
ANSI	: American National Standards Institute
API	: American Petroleum Institute
ASCE	: American Society of Civil Employer's Agents
ASME	: American Society of Mechanical Employer's Agents
ASTM	: American Society for Testing and Materials
BFP	: Belt Filter Press
BS	: British Standards Institution
BSPT	: British Standard pipe thread
CAD	: Computer Aided Drawing
CAM	: Computer Aided Manufacturing
CFD	: Computation Fluid Dynamics
CIP	: Cleaning in Place
COC	: Certificate of Conformance
D	: Diameter
DB	: Air Dry Bulb temperature

dB(A)	: Sound pressure level, "A" weighed in decibels
DCS	: Distributed Control System
DFT	: Dry Film Thickness
DIN	: Deutsch Industry Normen
DN	: Nominal diameter
DO	: Dissolved Oxygen
DP	: Differential Pressure
Eff.	: Filter efficiency in %
EPDM	: Ethylene Propylène Diène Monomer
ERW	: Electrical resistance weld
ETP	: Effluent Treatment Plant
FA	: Flange adaptor
FAT	: Factory Acceptance Tests
FBE	: Flanged both ends
FOE	: Flanged one end
FW	: Field weld
HDPE	: High Density Polyethylene
ID	: Inside diameter
ISO	: International Organisation for Standardization
JW	: Johannesburg Water
ℓ/s	: Flow in litres per second
LV	: Low Voltage
m	: Distance in metre
m.a.s.l	: Metres above (mean) sea level
m/s	: Air speed in metres per second
MCC	: Motor Control Centre
mm	: Dimension in millimetres
MPVC	: Modified Polyvinyl Chloride Pipes
MV	: Medium Voltage
N+1	: N units in operation + 1 installed spare
Nm ³ /hr	: Normal cubic meters per hour
O&M	: Operation and Maintenance
OD	: Outside diameter
OHS	: Occupational Health and Safety
Pa	: Pressure in Pascals
PBE	: Plain both ends
PE	: Plain end
PN	: Nominal pressure (Rating)
PPE	: Personal Protective Equipment
PQP	: Project Quality Plan
PSV	: Pressure Safety Valve
QCP	: Quality Control Panel
RFA	: Restrained flange adaptor
rpm	: Rotational speed in revolutions per minute
SAECC	: South African Electrolytic Corrosion Committee
SANS	: South African National Standards
SAT	: Site Acceptance Tests
SAW	: Submerged arc weld
SCADA	: Supervisory Control and Data Acquisition
SIS	: Swedish Institute of Standards
SOC	: Slip-on coupling
SS	: Soft Starters

SS	: Soft Starters
SS	: Stainless Steel
SST	: Secondary Settling Tank
STP	: Standard Temperature and Pressure (i.e. T = 20°C, P = 101, 3 kPa).
t	: Wall thickness of pipes
TDS	: Total Dissolved Solids
uPVC	: Unplasticised Polyvinyl Chloride
VSD	: Variable Speed Drive
WB	: Air Wet Bulb temperature
WB	: Air Wet Bulb temperature
WP (B)	: Weld preparation (Butt)

M05.1.4 Standards

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

SANS 10400	: National Building Regulations
PD 5304:2014	: Guidance on safe use of machinery
SANS9606-1: 1994	: Testing of welders, where applicable to the type of welding required
BS ISO1312-1:2018	: Rolling bearings. Accessories for sleeve type linear ball bearings. Boundary dimensions, geometrical product specifications (GPS) and tolerances for series 1 and 3
SANS 10162-4	: Structural use of Steel Part 4: The design of cold-formed stainless steel structural
SANS 15614-1	: Specification and qualification of welding procedures for metallic materials - Welding procedure test Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
SANS 10064	: The preparation of steel surfaces for coating
SANS 10102-1	: Selection of pipes for buried pipelines Part 1: General Provisions
SANS 10104	: Hand railing and balustrading (safety aspects)
SANS 10111-2-1	: Employer's Agenting Drawing Part 1: General principles Employer's Agenting Drawing Part 2: Geometric Tolerancing Section 1
SANS 10341	: Installation and maintenance of bearings – General guidelines
SANS 1700-5-9	: Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless-steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	: Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless-steel fasteners-Nuts

SANS 1034: 1975 : Grey iron castings
ISO 9000 : Quality management

M05.1.5 Other Particular Specifications

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

M04: Mechanical Equipment for Balancing Tanks

M06: Mechanical Aeration Equipment

M08: Mechanical Gearboxes

E01: Electrical Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

Volume 1: Automation and Control Design Standards SCADA

Volume 9: Automation and Control Design Standards Level Measurement

Volume 6: Automation and Control Design Standards Cabling

M05.2 **DESIGN OF MIXING EQUIPMENT**

M05.2.1 General Design Parameters

Mixing equipment shall be designed such that the following requirements are met:

- To ensure reasonable standards of engineering in design, materials selection and construction processes.
- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- The minimum availability of the equipment shall be 99 %.
- The offered equipment shall be support in forms of spares by the original equipment manufacturer for at least 15 years in alignment with the specified life expectancy from project installation.
- To ensure safe and satisfactory operation for an acceptable life expectation of 15 years under the ambient conditions prevailing at the Site.
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum that represent the value for money in both the initial purchase and subsequent running costs.
- To facilitate inter-changeability of units and/or sub-parts throughout the Contract works with regard to new equipment and equipment and/or sub-parts currently being used on the existing JW Wastewater Treatment Works.
- To operate without undue vibration and excessive noise. Maximum of 75dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements in respect of safety such as the Occupational Health & Safety Act , 1993 and Regulations as well as the prevention of water and air pollution.
- To satisfy any specific requirement contained in the latest editions of published statutory codes and legislation, and
- To be suitable for operation 365 days per year, 24 hours per day under

specified design conditions.

M05.2.2 Specific Mixer Design Parameters

All mixing equipment assemblies i.e. motor, gearbox and impellor shall be suitably surface mounted on concrete or steel platform as per structural design and fixed using hold down bolts. The Mixing equipment shall be designed to operate satisfactory under the atmospheric, ambient, operational medium conditions and any other conditions which is of importance for proper operation of the mixer. Non shrink grouting material shall be used underneath the base plate (where applicable) for the purpose of ensure a firm installation with the use of anchoring (hold-down) bolts, the grouting material shall be subject to approval by the Employer's Agent / Employer' Representative before application on site.

The approximation of compartment volumes required for the purpose of mixer design shall be based on approved construction drawing for specific process requirements.

The mixer design shall take into consideration mixed liquor may have a maximum suspended solids concentration of approximately 6 kg/m³ and shall be continuously mixed. The mixed liquor Design Sludge Volume Index (DSVI) will be between 80 and 240 ml/gm under normal operating conditions.

Power input and the flow pattern shall be such as to minimise vortex formation and surface turbulence and any undue oxygenation.

Mixed liquor will contain limited amounts of rags and fibrous material and the impellor blades shall be designed to prevent the build-up of this material on them.

In the event of a power outage, the mixers shall be capable of re-suspending all settled solids throughout the basin and the scouring velocity shall be a maximum as close to the floor as possible. Different materials of construction shall be insulated from each other to prevent corrosion due to galvanic reaction. The insulation material shall be subject to approval by the Employer's Agent / Employer's Representative.

Periodic stopping and restarting of the mixer units shall be accounted for in the mixer design and this should not be detrimental to the operation of the mixer units supplied. The duty cycle of the mixers shall be defined with a service factor or otherwise specified in the tender documentation provided.

The direction of rotation of the mixer impellor shall be as specified in the approved construction drawing or project specific specification.

M05.3 MIXER IMPELLOR DESIGN

M05.3.1 Impellor Design Parameters

Mixer impellers shall be of a dual impellor arrangement ensuring maximum mixing efficiency, consisting of a radial flow type impellor (flat back curved blade or retreating type) design to assist in centring the unit and promote self-cleaning, positioned suitably from the basin bottom creating the necessary radial mixing flow pattern. The axial flow type impellor shall be designed to prevent the undue accumulation of rags and debris material around the shaft at the liquid surface level. The axial flow impellor shall be installed at a distance of at least twice the impellor diameter below the liquid

surface but shall be not less than 800mm. The depth of the mixer impellor shall be taken into consideration for all operating conditions. This shall be designed based on the supplier mixer type. The final height of the mixer above the floor of tank shall be subjected to the approval of the Employer's Agent or Representative approval.

The radial impellor shaft mounting shall be rigid and adequate to sustain the impellor on the shaft for the long life of mixer operation, care shall be taken in the design of both axial and radial mixer mount to avoid loosening of the impellers during operation.

The mixing energy required for the radial flow type impellor shall be 4-5 W/m³ whilst the axial flow impellor shall impart a maximum of 0.5 W/m³ mixing energy. Mixing energy shall be defined as the actual power imparted into the mixed liquor via the impellor by drive unit (motor and gearbox assembly).

The tip speed of the radial flow impellor shall not exceed 2,5m/s

The shape of the mixer blades shall be such as to prevent surface movement, aeration of the mixed liquor and shear forces exerted on the surrounding liquid. An anti-vortex baffle or disc shall be incorporated in the impellor design to eliminate this condition. Tenderer's considering addition anti vortex baffles shall be required to indicate the requirement in their offer to achieve the desired mixing efficiency without any aeration. Full details shall be included in their tender. Any additional costs therefore shall be deemed to be included in their tender pricing schedules.

M05.3.2 Balancing Tanks Impellor Design Parameters

Balancing tank mixer shall be of single impeller arrangement, the mixer shall be installed with radial impellor only, unless specified otherwise in the project specification. The balancing tank mixers shall be designed to ensure adequate mixing is possible at low tanks levels without violating the original equipment manufacture's recommended operational level.

M05.3.3 Mixer Impellor Material

The mixer blades shall be manufactured from 304 L stainless steel plate with a minimum thickness of 6 mm unless specified otherwise in the project specification.

M05.3.4 Mixer Shaft

The shaft diameter shall be sufficient to prevent whipping or deflecting of the mixer shaft if rags and fibrous material collect on the shaft or blades. The shafts and bearings design shall allow for the out of balance forces that result from mixer operation at the Works. The shaft shall run at below critical speed and shall be able to operate at all liquid levels that may arise in the reactor.

Mixer shafts shall preferably be tubular to withstand all forces set up by the impellers and shall be manufactured in LDX 2101 Duplex Stainless Steel or alternatively a comparable 316L stainless steel (this alternative shall be evaluated and data for bending, corrosion, cracking and torsional loading shall be provided for review by the Employers Agent) and shall be structurally sound to prevent instability due to rag build-up.

The mixer shaft shall be rigid with flanges on both ends and designed to prevent any

eccentricity when installed in the field. Fitted machine bolts are preferred to join the shafts to the flanges and marking of the respective positions for installation shall be noted during manufacture. Special attention shall be paid to the alignment of gear output shaft, drive shaft and mixer impeller. Flanges shall be machined only after all welding has been completed.

The mixer assembly shall be statically balanced during manufacture and checked after installation for perceptible vibration or undue swaying under operating conditions.

M05.4 FASTENERS

Nuts, bolts, studs and washers for incorporation in the Works shall conform to the requirement of the appropriate approved standard.

Bolts shall be of such standard length that a minimum of two to four complete threads shall protrude beyond the nut when in the fully tightened condition. The same shall apply to stud units. Mating surfaces shall be adequately protected against corrosion whilst awaiting assembly of the faces and bolting, all to the approval of the Employer's Agent or Employer's Representative.

All high tensile bolts and studs used in the Works shall bear the letter HTS stamped or engraved on the end.

Washers shall be provided under all bolt heads and nuts. The threads of bolts and studs shall be lubricated before assembly with a lubricating substance subject to the approval of the Employer's Agent or Employer's Representative. Washers, locking devices and anti-vibration arrangements shall be provided where necessary and shall be subject to the approval of the Employer's Agent or Employer's Representative.

Stainless steel bolts, nuts and washers shall be in accordance with SANS 1700 A70 and the grade of stainless steel shall be subject to the approval of the Employer's Agent or Employer's Representative. Hot Dip Galvanised fasteners shall comply with the requirements of SANS 121. High strength friction grip (HSFG) bolts, nuts, load indicator washers and washers shall be subject to the approval of the Employer's Agent or Employer's Representative and shall be hot dip galvanised. High strength friction grip bolts shall be tightened in accordance with the manufacturer's recommendations and the tension shall be re-checked not less than 3 hours after first tightening and then the bolts shall be retightened to the initial load all to the approval of the Employer's Agent or Employer's Representative.

All stainless steel holding down bolts, nuts and washers in contact with a dissimilar material shall be provided with isolating washers and sleeves (insulating kit) where appropriate to prevent galvanic corrosion, unless otherwise specified in the project specification. The bed plates and machinery shall be provided with means of adjustment for line and level to maintain the items of Plant in correct alignment during grouting. Packers used for adjustment shall be of non-corrosive material to the approval of the Employer's Agent or Employer's Representative. Holding down bolts which are to be tightened after grouting shall be provided with bond breakers where they pass through the grout.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt and nut does not exceed half of the yield stress of the bolt

material under all conditions. The shear value of high strength friction grip bolts shall be reduced in proportion to the reduced tensile stress compared with the normal design stress.

No tapped holes in mild steel shall be allowed. Where tapped holes are unavoidable, this shall be done into stainless steel.

Where bolts and nuts are required to be removed and re-assembled on a regular basis, these shall be of stainless steel.

Metal coatings and other treatments applied to fasteners shall be carried out in a manner which will not cause hydrogen embrittlement of the parent material.

M05.5 GEARBOX ASSEMBLIES

Refer to Particular Specification M08: Gearboxes for a detailed specification on gearboxes.

M05.6 MIXER BASE PLATE

A robust designed hot dip galvanized base plate shall be used to fix the mixer drive unit securely to the mounting platform using 316 SS (chemical type) foundation bolts. The Contractor shall include for all necessary civil preparation work required on the platforms, drilling, core drilling for foundation bolt holes and spindles and grouting of bolts and base plates into position.

The Contractor shall also repair all non re-useable pockets and holes at the mixer positions to the satisfaction of the Employer's Agent / Employer's Representative.

The base plate shall elevate the mixer assembly to facilitate the draining of oil from the gearbox. The baseplate shall facilitate the inspection of the mixer and shaft coupling without lifting the gearbox from the mounting position above the platform floor.

M05.7 MIXER MOTORS

Motors shall be vertical flange mounted. The electrical motors shall be coupled to the gearboxes by means of a pin type flexible coupling. The input power of the mixer, when measured at the mixer shaft shall not be less than 5 W/m³. Weather hoods shall be fitted to all motors to prevent ingress of rain into the motor and protect the motor fan but must not cover ventilation of the motor. The design of the hoods shall be design by the motor supplier and must be submitted to the Employer's Agent or Representative for approval.

For a detailed specification for the electrical motors required refer to Particular Specification E01: Electric Motor.

M05.8 MATERIAL OF CONSTRUCTION

The equipment unit components shall be constructed using the critical material specified in the table below:

<u>COMPONENT</u>	<u>MATERIAL</u>
Mixer Blades	304 L stainless steel
Mixer Shaft	LDX 2101 Duplex Stainless Steel or alternatively a comparable 316L stainless steel
Mixer Base Plate	hot dip galvanized mild steel
Fasteners	316 stainless steel
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.	

M05.9 CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection.

M05.10 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall conform to Particular Specification G01: Colour Codes.

M05.11 MIXER PERFORMANCE

Information shall be supplied in the Tender of where and when such equipment has been previously installed. The Tenderer shall also indicate in his tender what mass, torque, radial load, bending moment, AGMA rating and mechanical power and thermal ratings are involved.

The performance of the mixers will be evaluated by checking that no sludge build-up occurs in any part of the reactor and that there is no air entrainment or vortices taking place within each zone of influence of each mixer supplied under this Contract.

M05.12 RECOMMENDED SPARE PARTS AND SPECIAL TOOLS

The Tenderer must submit on the appropriate schedule a priced list of spare parts which is recommended to be kept by the water treatment plant for maintenance of the plant. Spares which the Client 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.

For special tools being used on offered equipment. 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.

M05.13 GUARANTEE OF PERFORMANCE

The Defects Liability period shall be a minimum period of 12 months calculated from the date stated in the Completion Certificate. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Employer's Agent or Employer's Representatives reserves the right to extend the Defects Liability Period in respect of such portion or all of the plant and equipment for a further period of at least 12 months calculated from the date of Commissioning of such plant and equipment after rectification

M05.14 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE (QA)

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

M05.14.1 Manufacture

The Contractor's Quality Management System shall be in accordance with industry standard.

The Contractor shall implement a comprehensive Quality Control programme and accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Employer's Agent / Employer' Representative.

In keeping with the basic principles Quality Management System, the Contractor and Subcontractor(s) shall:

- Be responsible for compliance with all the requirements of the Specification in every respect;
- Carry out all inspections and tests called for in the Specification in the presence of the Employer's Agent / Employer' Representative. The cost of these inspections and tests shall be carried out at the sole expense and under the responsibility of the Contractor;
- Draft a Quality Control Plan for manufacture for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during manufacturing process of all components indicating all the intended stages of testing during manufacture, cleaning and preparation for application as well as necessary hold points for independent quality surveillance;
- Draft a Quality Control Plan for corrosion protection for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during corrosion protection process of all components indicating all the intended stages of testing during corrosion protection as well as necessary hold points for independent quality surveillance;
- Draft a Quality Control Plan for installation for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during installation process of all components indicating all the intended stages of testing during installation as well as necessary hold points for independent quality surveillance; and
- Draft Quality Control Plans for any other construction process as may be required for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during the execution of the process indicating all the intended stages of testing as well as necessary hold points for

independent quality surveillance.

The Quality Control Plans will not be compromised once approved and shall be adhered to at all times. The Contractor shall operate approved quality assurance and control programmes in the Supplier's and Manufacturer's premises and on Site in order to verify that the Works comply with this Section. Prior to the commencement of any work, the Contractor shall prepare and submit to the Employer's Agent / Employer' Representative for approval, quality plans describing the procedures, standards of acceptance, hold point inspections, routine and type tests to be carried out for each component both during manufacture and on Site.

Although it shall remain the responsibility of the Contractor to ensure that the Works conform to the Specification, the Employer's Agent / Employer' Representative shall be entitled to inspect, examine and test the materials, workmanship and performance of every item of Plant. The Employer's Agent / Employer' Representative will notify the Contractor which tests or inspections, detailed in the quality plan, he will attend.

Approval by the Employer's Agent / Employer' Representative of materials, workmanship, etc., during manufacture or at Site will not relieve the Contractor of his obligations to comply with all the requirements of the Contract.

All instruments and appliances necessary for the complete inspection and testing shall be provided by the Contractor. Calibration certificates for instruments shall be produced to the Engineer for review prior to the commencement of any tests and, if required by the Employer's Agent / Employer' Representative, instruments shall be re-calibrated at the Contractor's own account before commencement of the tests.

M05.14.2 Material Tests

The Manufacturer's material test data and the Contractor's quality records shall be subject to examination by the Employer's Agent / Employer' Representative. Reasonable samples of the cleaning and coating materials to be used may be taken for testing.

Rejection of the samples shall place a hold on the use of the materials of the same batch number and any components that have already been cleaned/coated with rejected material shall be re-cleaned and coated.

M05.14.3 Type Tests

Where the Contractor offers Plant selected from the standard range of products from a specialist manufacturer, type tests in accordance with a recognised international standard are required on one unit of each type to prove satisfactory design and quality of manufacture of that Plant.

The Employer's Agent / Employer' Representative may waive the requirement for type tests if he is satisfied that tests have previously been performed on identical Plant. The Contractor shall submit the data and results with his Quality Plan in sufficient time to allow for repeat tests without delaying the Works should the Employer's Agent / Employer' Representative not approve the evidence submitted

M05.14.4 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 Employer's Agent or Representative opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Employer's Agent or Representative 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.

M05.14.5 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 Employer's Agent or Representative 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 Employer's Agent or Representative's discretion.

M05.14.6 Performance Testing

Works testing

All Equipment shall be subject to a Factory Acceptance Test (FAT) by the Manufacturer and witness by Employer's Agent / Employer' Representative at the Manufacturer's premises before despatch. All performance test results shall be made available to the Employer's Agent / Employer' Representative for verification or when the QCP's require intervention or hold points for inspection. Equipment may only be despatch from factory once all relevant "hold points" on QCP's have been signed off by the Employer's Agent / Employer' Representative and/or the Approved Inspection Authority (AIA) in accordance with approved quality control plan.. All performance test results shall be made available to the Employer's Agent 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.

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 Employer's Agent.
- Check correct submergence of each impellor and adjust on the jacking bolts.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

During Commissioning

- Ensure all oil pumps and flow or pressure switches are functional.
- Check for correct operation of mixer rotation, speed, vibration and noise. These

values shall be measured and aligned with the OEM recommendation. These shall be used as benchmarks for continuous equipment monitoring.

- Note vibration readings.
- Note amperage drawn by each assembly.
- Visual check of excess vortexing at each mixer
- Check gearbox oil temperature after 6 hours of operation and take corrective action as required.

M05.14.7 Before Expiry of the Defects Liability Period

The Employer's Agent 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.

M05.15 **EQUIPMENT TRAINING PROCEDURE**

Training shall be provided by the Contractor (or specialist equipment suppliers) based on the supplied and approved operation and maintenance (O&M) manuals for all supplied equipment. This training shall be provided to the Operations and Mechanical including other support discipline staff of the Employer along with the Employer's Agent and/or Representatives. The duration of the training period shall be advised by the Contractor and agreed with the Employer's Agent and/or Representatives.

The training structure for the equipment and/or system should include both the theory and practical components of the equipment derived from the O&M manuals.

The preparation of the O&M manuals shall be based on the Johannesburg Water (SOC) Particular specification for Commissioning and Operation.

M05.16 **OPERATION AND MAINTENANCE MANUAL SUMMARY**

The Contractor shall hand over to the Employer' Agent or Employer's Representative four sets (x2 hard copies and x2 electronic copies on non-locked USB) of the Operation and Maintenance Manual compiled for each installation not later than at the time of commissioning of the installation. These manuals are a prerequisite for final takeover of the plant. A copy of the Operating and Maintenance Manual for each equipment type shall be bound in with the Operating and Maintenance Manual for the project. The manual shall be A4 size and properly bound. Drawings larger than A3 size shall be contained in separate plastic pockets.

The Operation and Maintenance Manual will contain the following:

- Brief description of the plant and installation.
- Concise operating instructions including start-up, operating, shutdown and troubleshooting procedures.
- Routine maintenance instruction this shall include failure mode analysis and preventative strategies.
- Precautionary measures, elementary trouble location, rectifying measures and emergency actions.
- Detailed information on equipment.
- Lists of spare parts including names and addresses of suppliers.
- Schematic Diagram and Drawings
- Risk, Health and Safety Assessment with proposed control measures.

M05.17 DRAWINGS

The drawings included in the Tender Documents are the Employer's Agent or Employer's Representative. 's proposal for the plant layout. Should the Tenderer offer alternative layouts, they shall submit drawings with his Tender in order for it to be evaluated.

Before the Contractor carries out any work, he will submit detailed working drawings to be approved by the Employer's Agent or Employer's Representative. Approval of these drawings does not relieve the Contractor from his responsibility for the correctness of the drawings.

M05.18 INTERCHANGEABILITY

Where two or more similar types of equipment are required, these units will be identical in all respects.

All similar parts of items supplied will be interchangeable without any additional machining or fitting.

M05.19 MEASUREMENT AND PAYMENT

No separate payment will be made for required equipment unless otherwise specified in the detail/project specifications. All direct and indirect costs associated with such required equipment shall be deemed to be included in the rates tendered for the equipment.

Where separate payment is required for equipment and specified as such in the detail /project specifications, the following payment items shall be applicable:

M05.19.1 General

The following items shall, inter alia, be included in the rates:

- Supply of all design and pre-manufacture documentation and obtaining approval thereof;
- Procurement/manufacture of required equipment with associated equipment items and delivery to Site;
- Installation of complete required equipment with associated equipment items and testing;
- Services required during period of initial use before handover to the Employer.

Payment under scheduled items shall be made per complete installation as specified, electrical connections, etc and grouting, etc. Measurement and payment will distinguish between supply / delivery; installation and testing; and commissioning and trial operation of the equipment.

M05.19.2 Supply and delivery to site with documentation

<u>Item</u>	<u>Unit</u>
Supply and delivery to site with documentation.....	No

The tendered rates shall include for full compensation of all costs incurred in design,

drawings, manufacture, supply, testing at the manufacturers works, inspections, quality control, quality assurance, factory acceptance testing, corrosion protection, packing, delivery to site including transportation costs and offloading on site including any craneage requirements. 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.

M05.19.3

Installation, Testing and Commissioning of the Equipment

Item

Unit

Installation, Testing and Commissioning of the Equipment.....No

The tendered rates shall include for full compensation of all costs incurred in installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified on Site including the provision of all labour, supervision, instruments, equipment, transport, on-site quality assurance and quality control, inspection and testing (including attendance at tests witnessed by the Employer's Agent / Employer' Representative), materials and Temporary Works necessary to completely install, test and commission and render fully operational surface aeration equipment.

The rate shall also include the cost of the installation of all auxiliary equipment 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 until taken over by the Employer; the putting into service of the complete installation; remedial work and any other work as specified and necessary.

The rate shall also include for all preliminary testing and the provision of testing equipment therefore including all disruptions to installation caused by such testing.

Payment will only be effected after full compliance of the equipment items with this Section and associated documentation has been approved by the Employer's Agent / Employer' Representative.

The Contractor shall include in the Tendered rate for straining of the gearbox oil after 600 hours of initial operation. The Contractor shall furnish the Employer's Agent with a report recording any irregularities when cleaning the sieves after straining.

M05.19.4

Trial Operations

Item

Unit

Trial Operations.....No

This specification allows for a number of calendar days within which the system Trial Operation can be completed after completion of commissioning process. The Contractor shall programme and price for providing full technical and operational support during trial operation.

M05.19.5 **Employer's Operator Training**

<u>Item</u>	<u>Unit</u>
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Training	No
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Payment for Training of the Employer's Operational Staff will be made under this Section as set out in project specification or agreed with the Employer's Agent / Employer' Representative. The lump sum shall be inclusive of all costs associated with the training programme and on-site training of personnel.

M05.19.6 **Spares Equipment**

<u>Item</u>	<u>Unit</u>
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Spares	No
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The cost of spares, considered to be necessary by the Contractor other than spares required by the Employer, delivered to Site and handed over will be paid as a lump sum. A Spare Part Schedule subject to approval by the Employer's Agent/ Employer's representative shall be submitted before procurement of spares.

The actual lump sum to be paid shall be based on the unit rates priced in the Bill of Quantity for the actual spares ordered and supplied and the Employer is entitled to purchase all, some or none of the items listed. A provisional sum will be allocated in the Bill of Quantity for the complete list of spare parts as listed by the Contractor. The rate tendered shall provide for the manufacture, supply, delivery to Site and handing over of the spares ordered and shall include permanent packing for long term storage. The spares shall be manufactured at the same time as the installed items.

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