

# **JOHANNESBURG WATER (SOC) Ltd.**

## **BULK WASTEWATER**

### **PARTICULAR SPECIFICATION**

#### **M02: H.O.W MECHANICAL DEGRITTER SYSTEM EQUIPMENT**



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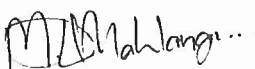


## DOCUMENT CONTROL SHEET

Document Title: Particular Specification – M02: H.O.W MECHANICAL DEGRITTER SYSTEM EQUIPMENT

JW Reference: ???

Document Ref. No: M02

## DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Mechanical Engineer (Hatch)	Mbongiseni Mahlangu, Pr Eng.	01.06.2022	
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## RECORD OF REVISIONS

Date	Revision	Author	Comments
2021-09-17	5	J Prinsloo	Detailed Review
2013-10-23	4	J Ritchie	Minor updates and re-issued
2012-07-30	3	T Wellard	General review
2010-02-16	2	J Ritchie	General review
2009-05-12	1		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

**PARTICULAR SPECIFICATION: M02: H.O.W MECHANICAL DEGRITTER SYSTEM EQUIPMENT**

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## M02.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, off-loading on site, installation, testing and commissioning of degritter system equipment. The Specification shall be read in conjunction with the Project Specification and other relevant reference Specifications.

## M02.2 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

### M02.2.1 Definitions

For the purpose of this Specification the following definitions 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
- (e) **“Degritter System”** shall refer to a system of equipment used to remove inorganic particulate materials with high specific gravities such as sand and small mineral particles from an influent wastewater. These are primarily used to prevent sediment formation in channels and pipelines and to protect downstream equipment from the Head of Works (HoW) such as pumps and other equipment from the abrasion and wear effect.
- (f) **“Grit”** shall refer to all inorganic materials consisting of sand, gravel material or other heavy material having the specific gravity or settling velocities considerably greater than those of the organic material found in the influent wastewater.

### M02.2.2 Abbreviations

In this Specification the following abbreviations will apply:-

°C	: Temperature in degrees Celsius
A	: Ampere
AC	: Alternating Current
AGMA	: American Gear Manufactures Association
ANSI	: American National Standards Institute
API	: American Petroleum Institute

ASCE	: American Society of Civil Engineers
ASME	: American Society of Mechanical Engineers
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
BSPT	: British Standard Pipe Thread
CAD	: Computer Aided Drawing
CAM	: Computer Aided Manufacturing
CIP	: Cleaning in Place
COC	: Certificate of Conformance
Dia	: 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
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	: metre
m.a.s.l	: Metres above (mean) sea level
m/s	: metres per second
MCC	: Motor Control Centre
mm	: millimetres
MPVC	: Modified Polyvinyl Chloride Pipes
MV	: Medium Voltage
N+1	: No. of units in operation + 1 installed spare
Nm <sup>3</sup> /hr	: Normal cubic meters per hour
O&M	: Operation and Maintenance
OD	: Outside diameter
OHS	: Occupational Health and Safety
Pa	: 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	: 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	: Stainless Steel
STP	: Standard Temperature and Pressure (i.e. T = 20°C, P = 101, 3 kPa).
w.t	: Wall thickness of pipes
TDS	: Total Dissolved Solids
uPVC	: Unplasticised Polyvinyl Chloride
VSD	: Variable Speed Drive
WB	: Air Wet Bulb temperature
WP (B)	: Weld preparation (Butt)

#### M02.2.3 Standards

All design standards for the degritter 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 (British Standards Institution)
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	: Engineering Drawing Part 1: General principles Engineering 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 1217	:	Internal and external organic coating protection for buried steel pipelines.
SANS 719	:	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 50025	:	Hot rolled products of structural steels
SANS 1476	:	Fabricated flanged steel pipework
ISO 8501-1	:	Preparation of steel substrate before application of paints and related products (International Organization for Standardization)

#### M02.2.4 Other Particular Specifications:

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

M08: Particular Specification for Gearboxes

M18: Particular Specification for Centrifugal Pumps

M20: Particular Specification for Valves

M21: Particular Specification for Pressure Pipework

E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

Volume 1: Automation and Control Design Standards SCADA

Volume 6: Automation and Control Design Standards Cabling

Volume 8: Automation and Control Design Standards Flow Measurement

Volume 9: Automation and Control Design Standards Level Measurement

Volume 23: Automation and Control Design Standards Pressure Measurement

### **M02.3 GRIT REMOVAL SYSTEMS**

#### M02.3.1 General Design Parameters

Grit Removal System 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,
- To ensure safe and satisfactory operation for an acceptable life expectation of 15 years under the ambient conditions prevailing at the Site,
- 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 expectation of 15 years from project installation,
- The minimum availability of the equipment shall be 99 %;
- 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 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 the published statutory codes and legislation
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions, and
- To operate without undue vibration and excessive noise with maximum noise reduction of 75dBA measured at 1 metre generated from operating the equipment.

#### M02.3.2 Design Parameters

The removal of grit from the influent wastewater prevents grit deposits in pipelines, pump sumps and channels, unnecessary abrasion and wear of mechanical equipment and the accumulation of grit downstream of the Head of Works (H.O.W) treatment areas such as the primary sedimentation tanks, anaerobic digesters and aeration basins. Therefore, the Degritter system shall be installed immediately downstream of the screening equipment but upstream of pumps and other treatment units.

The Degritters system shall be of the gravity separation in an accelerated flow field chamber type design i.e. Grit Chamber type.

#### M02.4 **Design Criteria for the Grit Chamber**

Degritters shall be designed to remove particles having a nominal diameter equal to or greater than 0.2mm and a specific gravity of 2.65 and a settling velocity of 25mm/sec. The minimum settling velocity shall correspond to the minimum site-specific temperature. The retention time of the particles shall be in the range of 2 - 5 minutes at peak hourly flow. The tank design dimensions will be provided per project specific treatment capacity requirements shown in the Tender drawings and project specification.

The degritters shall be designed to operate continuously and in such a way that the tangential inlet velocity creates a rotary motion to the tank contents of such a velocity that the grit particles tend to settle out whilst leaving the lighter, principally the organic particles to remain in suspension and subsequently passing the tank.

##### M02.4.1 Grit Chamber

The grit chamber shall be a conical vortex type chamber. The particles contained in the sewage and the influent sewage shall move at the same velocity as they enter and the resulting effluent shall also exit the chamber tangentially, creating a vortex flow pattern. The tangential inflow along the peripheral wall of the chamber assists in the grit removal process and results in additional head losses. In order to get the maximum amount of grit collection in the hopper, a sloping bottom design shall be used.

The grit settles by gravity and the effluent exists at the top of the tank. The grit chamber shall be designed to create an updraft at the centre of the chamber. This updraft draws the slurry across the tank bottom toward the centre where the grit falls into the hopper. The grit in the hopper is then removed by an airlift pump.

In a sloping bottom design, the grit flow shall follow a 270° path before leaving the chamber. This ensures that no short-circuiting occurs. The combination of the conical and circular shapes incorporated in the sloped design result in a considerable reduction of flow turbulence due to the natural vortex and the gravity forces in the chamber. The resulting flow pattern results in efficient separation of the grit from the organic solids.

Where a rotating Propeller or Paddles are required to mechanically induce the vortex that settles the grit for a specific project, the following shall apply;

- A constantly rotating axial flow propeller shall be employed to only maintain a constant tangential velocity to assist in separating organic and inorganic material i.e. grit. This capability shall apply even with changing hydraulic conditions i.e. peak loadings, average loading and minimum sewage inflows.
- The axial flow impeller Paddles shall be able to induce a minimum tangential velocity of 0.6 m/s into the influent inside the grit chamber. The rotating paddles shall be adjustable to define the required vortex. The design of the paddles shall be submitted by the Tenderer.
- The rotating propeller shall be mounted on the drive torque tube driven by a drive unit. The drive torque tube shall be driven by a suitably sized parallel geared motor with a minimum service factor of 2. The gearbox unit cover or mounting shall allow the associated process pipes to pass through the drive tube. Tenderers shall refer to the M08 Mechanical Gearbox and E01 Electrical Motor particular specification for specific drive unit details.

#### M02.4.2 Walkways

Walkways and bridges access with handrails and landings to the grit removal systems shall be supplied and shall not be obstructed with pipelines or cables.

#### M02.4.3 Welds and Fasteners

All welds are to be in accordance with SANS 15614-1.

All submerged fasteners shall be 316 SS and mating flanges shall be sealed against the ingress of any crevice corrosion by means of a sealant suitable for underwater conditions and approved by the Employer's Agent or Employer's Representative.

#### M02.4.4 Inlet Channels

The straight inlet length of the channel is typically seven times the width of the inlet channel or 4.6 m, whichever is greater. This will be defined on the project specific specification and or the approved Civil Engineering drawings.

A minimum velocity of 0.60 m/s should be maintained at all times to ensure that the grit is carried into the grit chamber.

### M02.5 **GRIT HANDLING**

The heavier solids collect in the grit hopper and the lighter solids are retained in the water flow. The slurry is then separated into the basic components of water, organics and grit through the grit separation, washing and dewatering process.

Grit removal from the chamber to the dewatering process employs an airlift system. The removal of grit shall be controlled by the PLC.

M02.5.1 AIRLIFT SYSTEM

Directly after fluidising with compressed air and prior to airlifting the grit is washed by the injection of low-pressure wash water or effluent. The water shall be controlled by the PLC in conjunction with the airlift operation.

M02.5.1.1 AIR Compressors

Prior to washing and airlifting the grit is fluidised by an injection of high-pressure air from the compressors. The air injection shall be PLC controlled in conjunction with the water washing and airlift operation.

The compressors shall be of either rotary screw or reciprocating type based on the application and operational requirements. The design shall be robust, and applicable for industrial applications to offer Class 5:3:3 of air quality in accordance with ISO 8573.1 2010 unless otherwise stated in the Project Specification. The air receiver vessel installed downstream of the compressor shall be designed to handle at least four (4) times the volume of air required in the degritter with the compression system duty cycle of between 25% and 75%

The compressor shall continuously operate at least 168 hours before any maintenance inspections shall be required. If the system design requires the installation of two compressors in a duty / standby configuration in order to maintain the minimum availability of the equipment of 99 %, the standby capacity shall be 100%. Pressure switches shall be provided to switch the compressors on and off as per the air requirements demand. A non-return valve shall be installed on each of the compressor discharge outlet, to prevent stall when switching between a duty and standby compressor.

The materials and equipment to be supplied and installed shall be selected appropriately and be fit for the purpose to operate under site specific environmental conditions as specified in the project specification / tender documentation which shall include, but not limited to, altitude, seasonal conditions ( temperature and air conditions ) and area conditions ( indoor or outdoor conditions, moisture content, noise requirements).

The compressor inlet valve shall open with minimum resistance and have sufficient area of opening to permit free entrance of air, and the valve shall be of light weight to operate with minimum noise and shock.

The compressor discharge valve shall be strong enough to withstand the maximum cylinder pressure, be capable of closing promptly at the end of the delivery stroke, fit accurately on the seat to prevent leakage and have ample guiding surface to ensure accurate alignment in movements.

Reciprocating compressors shall be provided with the air receiver as specified in this specification, the receiver shall be placed as close as possible to the compressor delivery. The air receiver shall be of a robust and standard vertical design type. The design, manufacture , supply, and certified as per the strict requirements as stated in the latest edition of the New Pressure Regulation as per the Occupational health and safety act. No. 85 of 1993. All pressure accessories shall be supplied including the safety valve, drain valve, inspection cover (where applicable) and instrumentation nozzles. The footing/support of the air receiver shall be manufactured as a one piece item with the receiver tank.

The air supply systems installed shall be suitable in all respects for operation under the atmospheric and installation conditions and electricity supply as outlined in reference Electrical Particular Specification. The Contractor shall ascertain any other local

conditions or peculiarities which might affect the working of the equipment and adjust the system accordingly without any additional payment or change in standards of materials and equipment supplied or workmanship in this respect. This also applies to the nature and construction of the building, details of which shall be indicated on the tender drawings

The air shall also be filtered in order to limit the oil content of the air to less than 0.5 mg/m<sup>3</sup>. A duplicate filter system shall be provided in parallel to ensure that the units can be serviced without shutting down the system.

The air receiver shall be drained by a timer operation solenoid or automatically controlled valve from the bottom at regular intervals to prevent the accumulation of condensation in the receiver. Upstream of this valve, there shall be a manual isolation valve to allow the maintenance, replacement of the controlled valve

#### M02.5.1.2 Safety Precautions and Protection on Compressor System

A certified pressure relief valve on both the compressor and receiver vessel shall be installed as a safety precaution against over pressure. This valve shall restore to a close position once the vessels have de-energized. The receiver shall also be fitted with pressure gauge for visual pressure monitoring.

Reciprocating compressors which is not provided with automatic means for limiting the operating temperature to a safe level shall provide a fusible plug fitted close to the outlet valves or discharge ports of every stage of compression. The fusible plug shall be fitted in position that minimised the accumulation of oil film or dirt which can hinder their effective use.

For the purpose of high temperature, a thermometer having the maximum permissible temperature clearly marked shall be fitted close to the outlet valve to monitor the exit air temperature.

Lubrication shall be by sight feed lubrication and preference shall be for mechanical means controlled by the speed of the compressor to minimise carbonisation and valve clogging. Vegetable or animal oil shall not be used for lubrication.

The use of paraffin to clean the compressor cylinder and valve is no allowed.

Oil level sensors shall be provided in order to prevent the compressor from malfunctioning. It is a requirement of this specification that this malfunction in operation be reflected on the works SCADA system. This will require that a potential free contact capable of switching 500 mA at 230 Volts AC will be provided.

#### M02.5.1.3 Controls

The compressor(s) shall be complete with the following:

- Overload relay protection
- Automatic full load, no load, idle run capacity control
- Automatic re-start after power cut
- Main on/off switch with emergency stop
- Rotation direction control
- Oil level monitoring sight glass
- Temperature and pressure gauges
- Alarms for: motor overloading:
  - compressor overload
- Safety devices for:
  - high motor temperature:

- high compressor temperature
- high compressor pressure
- Low Pressure Switch
- Moisture separator and drain

Potential free contacts capable of switching 500 mA at 230 Volts AC must be provided for the following interface signals to a PLC/SCADA system:

- a) Compressor Running
- b) Low pressure in the air receiver
- c) Compressor fault of a general nature.

The compressor must not be allowed to start unless an interlocking potential free contact from a PLC / SCADA system is closed.

#### M02.5.1.4 Drive Unit

The air compressors shall be driven by electric motors using V-belts. The motor shall be a standard IE3 high efficiency motor and be suitable for outdoor installation. Refer to Particular Specification E01: Electric Motors for a detailed specification on Electric motors. Each motor is to be protected by an Intelligent Protection Unit incorporating phase angle protection relay and protection against over and under load conditions, (broken V belts).

#### M02.5.1.5 Noise

Consideration shall be given to the operating noise level of the compressor installation. The noise level shall not exceed 75 dB(A) per 1 m.

If deemed necessary, the contractor shall include a noise suppression housing with the compressor unit.

The compressors shall also be tested under operating conditions to demonstrate compliance of the delivery rate, the over pressure release and other parameters specified.

Should the noise level after installation exceed the noise limit stated in this specification; the Contractor shall take the necessary steps to reduce the noise level to acceptable level in compliance with this specification at his own cost.

#### M02.5.2 Air Blowers

The air blowers shall be of the "Roots" Type and have impellers which are dynamically balanced and with the entire rotating assembly being dynamically balanced to ensure smooth vibration free operation. The blower must be capable of operating at higher speeds for increased flow capacities.

The air blowers shall be complete with the following:

- Electric motors
- V-belt drives and enclosures
- Air filters
- Inlet and discharge silencers
- Relief valves
- Water pipes
- Drains

- Oil Level Switch
- Delivery pressure gauges
- Base plates
- Foundation bolts etc. must be provided for filter scouring

Two units shall be provided, one unit shall be duty and the other unit shall be used as a standby by unit.. These shall be individually sized for 100% of the duty required air to operate the grit removal system based on the air flow requirement.

*M02.5.2.1.1* Rotors

Rotors shall be designed as to not deform under air pressure up to at least double the normal operating pressure. The rotors are to be milled from high tensile strength ductile iron that has been stress relieved and dynamically balanced assuring extra strength and rigidity to handle maximum loads on a continuous basis without fatigue, deflection or vibration.

Rotors shall not be oil lubricated.

*M02.5.2.1.2* Drive Unit

The air blowers shall be driven by electric motors connected to the blowers by means of V-belts. The motor shall be a standard IE3 high efficiency motor and be suitable for outdoor installation. Refer to particular specification E01: Electric Motors for a detailed specification on Electric motors. Each motor is to be protected by an Intelligent Protection Unit incorporating phase angle protection relay and protection against over and under load conditions, (broken V belts).

*M02.5.2.1.3* Bearings

Anti-friction bearings with thrust control, rated for a minimum L-10 life of 100 000 hours. The anti-friction bearings shall be designed to carry the shaft loads and fix the rotor into position. The bearings shall be lubricated with a splash oil system resulting in longer bearing life at all operating conditions and minimal maintenance.

*M02.5.2.1.4* Housing

The blower casing, shafts, gears and rotors shall be of high quality special steel or cast iron where applicable and protected against corrosion on the inside and outside in compliance with Johannesburg Water (SOC) LTD's Corrosion Protection Specification G02

*M02.5.2.1.5* Lubrication

Blower discharge shall be completely free of oil and the rotors shall not be oil lubricated. The synchronizing gears shall be housed in a separate compartment and shall be oil lubricated. Oil reservoirs shall be provided with sight glasses for level indication and will be fitted with a low oil level switch and reflected on the PLC/SCADA system.

*M02.5.2.1.6* Noise

Consideration shall be given to the operating noise level of the blower installation. Blowers which have large dimensions with lower operating speed shall be given preference. The blower speed shall not exceed 1200 rpm.

If deemed necessary, the contractor shall include a noise suppression housing with the

blowers.

The noise level shall be equal to or lower than the noise level of 75 dB(A) per measured at 1 m from the blower. The blowers shall also be tested under operating conditions to demonstrate compliance of the delivery rate, the over pressure release and other parameters specified.

Should the noise level after installation, exceed the noise limit stated in this specification, the Contractor shall take the necessary steps to reduce the noise level to that acceptable level in compliance with this specification at his own cost.

**M02.5.2.1.7 Blower Discharge Manifolds**

Each complete blower unit must include all special flanges, tapered connections, approved rubber pads for resilient mounting, a high-quality non-return valve and an isolating stop-valve in the discharge pipe. Refer to Particular Specification M20 for detail on valves. Blowers shall be coupled to the discharge pipe work by means of flexible connecting pieces to minimise the transmission of vibration and noise. Refer to Particular Specification M21: Pressure Pipework for detail on pipework.

**M02.5.2.1.8 Air Line**

The air line from the blower to the grit chamber shall be complete with valves, water traps, drains, thermal expansion joints etc. and shall be provide under this section unless otherwise indicated.

The air supply line from the blowers to the grit chamber shall be made of stainless steel. The pipe shall be flanges or plain ended for flexible couplings and not screwed joints.

**M02.5.2.1.9 Pipeline Diameters**

Pipeline diameters, where not given on the Tender drawings shall be determined by the Tenderer to suit the plant offered and to conform to velocities, which may be given on the drawings or in the Project Specifications. Where velocities are not specified, the Tenderer shall provide the design velocities in the information supplied for the Employer's Agent/ Employer's Representative approval.

**M02.5.2.2 Safety**

The safety guards over the blower coupling must be made from a steel mesh and shall be such that the coupling may be inspected without removing the screen. This shall be correctly identified by marking or coating as per the Johannesburg Water (SOC) LTD's Colour Code Specification. G01

**M02.5.2.3 Testing**

Blowers shall be factory tested for compliance with the performance and coating specifications and test certificates shall be supplied to the Employer's Agent or Employer's Representatives before delivery commences. The tested blower performances shall be within 5% of the operating curve of the blower offered in the Tender. Operating curves must be submitted with the Tender. The Employer's Agent or Employer's Representatives must be given 14 days' notice (or as per the project agreement) of such tests so that his representative and/or that of the Employer, can witness the tests.

The noise level shall be equal to or lower than the noise level stated by the Tenderer in his Tender or 75 dB(A) per 1 m whichever is lower. The blowers shall also be tested under operating conditions to demonstrate compliance of the delivery rate, the over

pressure release and other parameters specified. Should the noise level after installation, exceed that stated in the Tender. The Contractor shall take the necessary steps to reduce the noise level to that accepted at his own cost.

#### M02.5.3 Grit Washing

The grit removed from the grit removal system requires washing in order to reduce the odour of the grit removed.

The grit washing system shall be designed for the following characteristics:

- Wash the grit to remove inorganic material at an efficiency removal better than 95%.
- Overflow from the grit washing system shall have a grit content of no more than 5% carry over.

The grit washer shall comprise of a primary settling zone (concentrator) and a screw classifier. The primary settling zone separates the lighter substances and excess water from the grit, while the screw classifier further dewateres the grit and carries it to disposal.

The primary settling zone is designed to reduce the volume of the liquid and to concentrate the grit so that a smaller more efficient screw classifier can be used.

It is envisaged that approximately 6% of the total flow to the grit washing system will continue to the screw classifier for dewatering while the remaining 94% overflows back into the inlet channel upstream of the vortex grit removal systems.

The 6% handled by the screw classifier results in clean grit with a sandy texture free from odour.

#### M02.5.4 Grit Disposal

The grit shall be disposed into a skip, which shall be positioned under the grit discharge chute in to the 6m<sup>3</sup> skip bins. The sizing and orientation of the discharge chute shall be based on the skip design and positioning. The skip requirements will be defined in the project specification.

#### M02.5.5 Grit classifier

The grit classifier is to be of the screw type and is to be designed to receive liquid/solid mixtures from the underflow of the primary settling zone, settle the solids into the trough and convey the solids via a rotating spiral to a discharge point. The grit classifier system shall be individually sized for 100% of the duty/standby required capacity to operate the grit removal system.

The dewatered grit shall comply with section 5(1)(q)(ii) of the National Norms and Standards for Disposal of Waste to Landfill (GN R. 636 of 23 August 2013) promulgated in terms of the National Environmental Management: Waste Act, No 59 of 2008, as amended. Section 5(1)(q)(ii) restricts disposal to a landfill site any waste that fits the following criterion:

- Waste with a moisture content of less than 40% or that liberates moisture under pressure in landfill conditions, and which has not been stabilised by treatment

The classifier mechanism shall be an inclined helical screw type. The angle of inclination shall be designed by the grit classifier designer and submitted to the Employer's Agent or Employer's Representative for review and approval. The screw shaft shall preferably be a hollow, seamless and continuous shaft with spiral flights.

Where not practically possible to supply a continuous screw shaft. A multi-screw shaft(s) may be offered, the Contractor shall submit the full design of the screw shaft to the Employer's Agent or Representative for acceptance. The shaft shall not be jointed on where a maximum deflection of the entire screw assembly will occur.

If the classifier receives too high hydraulic loads, the solids shall be carried over into the overflow weir.

The grit classifier shall be PLC controlled to ensure full discharge of the washed/dewatered grit based on the control philosophy.

#### M02.5.5.1 Helical Screw

The helical screw shall have easily-replaceable hardened wearing surfaces and shall be designed in such a way for the removal and replacement of the screw for maintenance. The screw shall operate at a maximum of 10 rpm

The upper end of the screw shall have a connection on the one side to ensure that the screw is continuously flushed. The connection shall be equipped with a shut off valve.

The helical screw shall be of a shaft-less design., Where shaft design is offered , the shaft design shall be robust with due consideration to the maximum bending deflection. No joint shall be allowed on the maximum deflection position.

To ensure effective grit transfer the pitch of the screw shall not exceed 250 mm.

#### M02.5.5.2 Helical Shaft Bearings

The lower bearings shall be enclosed in a watertight assembly suitable for submerged operation in grit service. The bearing shall have an L-10 rating life of 100 000 hours while operating at maximum load. Internal bearing parts shall be completely sealed from outside contamination.

#### M02.5.5.3 Screw Assembly

The screw assembly shall have a manually operated device to lift the lower bearing above the maximum water level. The helical screw shall be comprised of steel flight sections welded to the shaft

#### M02.5.5.4 Screw Trough

The side walls of the tank shall be sloped in order to minimise the accumulation of sludge and sediment deposits.. Design of the screw trough shall have wearing pads or lining fitted. The gap/clearance between the lining or wearing pads and the screw flight tip shall ensure there is minimum backflow. Furthermore, the clearance shall be at least more than the minimum bending/deflection of the helical screw. A minimum of 4mm lining or wearing pads shall be used.

#### M02.5.5.5 Drive Unit

The screw-drive unit shall be mounted on the top of the screw trough and shall be enclosed.. The reducer output shaft shall be directly coupled to the upper end of the screw classifier.

Refer to Particular Specification M08: Mechanical Gearboxes for a detailed specification on gearboxes and also refer to Particular Specification E01: Electric Motors for a detailed specification on electric motors.

## M02.6 PIPEWORK

Pipeline shall incorporate purging provision for the purpose of mitigating against grit settlement and blockage. Refer to particular specification M21: Pressure Pipework for a detailed specification on pipework.

## M02.7 MATERIAL OF CONSTRUCTION

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

<b><u>COMPONENT</u></b>	<b><u>MATERIAL</u></b>
Walkways and handrails	304L stainless-steel
Rotating "PISTA" propeller and support structures on grit chambers	304L stainless-steel
Helical Screw	304L stainless-steel
Helical trough (Including Wear Strips)	304L stainless steel
Blower housing	Epoxy coated Cast iron
Grit classifier Structure	304L stainless-steel
Grit classifier covers	Clear UV Plastic
Knife gate Valves	304 stainless steel blade and spindle
Grit Hopper	304L stainless-steel
<b>Pipework</b>	
Compressor pipework	Carbon Steel Hot Dip Galvanised
Grit Conveyance Pipework	rubber lined 304L stainless-steel
Air blower pipework	304L stainless steel
Air lift pump	304L stainless steel
Valves Internals and levers	304L stainless steel
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.	

## M02.8 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 Galvanized fasteners shall comply with the requirements of SANS 121. High strength friction grip (HSFG) bolts, nuts, load indicator washers and washers shall subject to the approval of the Employer's Agent or Employer's Representative and shall be hot dip galvanized. 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

## **M02.9 CORROSION PROTECTION**

Refer to Particular Specification G02: Corrosion Protection.

## **M02.10 COLOUR CODES**

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

## **M02.11 DESIGNATION AND INFORMATION PLATES**

Each pump/blower & compressor shall be supplied with an information plate secured to the pump/blower casing in a visible position indelibly marked with the following

details :-

- Maker's name, pump/blower & compressor type and serial number
- Year of manufacture
- Rated duty of pump in litres per second
- Head in metres at rated duty
- Pump speed in r/min
- Mass of completely assembled pump in kilogram

#### **M02.12 INTERCHANGEABILITY**

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

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

#### **M02.13 RECOMMENDED SPARE PARTS AND SPECIAL TOOLA**

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.

Minimum spare parts on the recommended list:

- Bottom bearing unit of grit classifier screw.
- Bearing gland packing.
- Compressor spares as per OEM's recommended Spares List.

#### **M02.14 GUARANTEE OF PERFORMANCE**

The Defects Liability period shall extend over a 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

#### **M02.15 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE (QA)**

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

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 always be adhered to . 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 Employer's Agent or Employer's Representative 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.

In general, Quality Management System should be bench marked in accordance with the relevant ISO 9000 requirements.

M02.15.1 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.

M02.15.2 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.

M02.15.3 Substandard Quality Control

All material, certification and records of the Contractor shall be subject to examination by the Employer's Agent / Employer' Representative.

This shall include the checking and testing of the Plant at the Works and on Site, installation and pre-acceptance testing. If any deviation is found, additional testing and quality surveillance shall be carried out at the Contractor's own costs until approved by the Employer's Agent / Employer' Representative.

If the additional testing confirms inaccurate quality control by the Contractor on an item of Plant, all work shall be stopped on that item of Plant and shall only proceed after remedial action in the quality control system has been implemented.

M02.15.4 Access for Surveillance

For the purpose of carrying out quality surveillance, the Employer's Agent / Employer' Representative shall be granted access to any part of the Contractor's premises relevant to the work being carried out, at any reasonable time.

M02.15.5 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.

**M02.15.6**      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.

**M02.16**      **SYSTEM PERFORMANCE**

**M02.16.1**      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.

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

The compressor shall be subject to volumetric efficiency, mechanical efficiency and compression efficiency. Internal examination and hydraulic test of the receiver in compliance with the specific equipment manufacturing standard shall be witness by the Employer's Agent / Employer's Representative.

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.

**M02.16.2**      Before commissioning

- Check for correct lubrication levels in all rotating equipment and that motor bearings are greased properly.
- Ensure all HD bolts are torque 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 or Employer's Representatives
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.
- The Contractor shall provide a minimum method statement for the Site Acceptance test and detail how the performance of the grit removal system shall be verified. The guidelines for the requirement of this document is detailed in the Johannesburg Water Commissioning Specification.

**M02.16.3**      During Commissioning

The commissioning stages, shall include but not limited to the following checks:

- Ensure all axillary components of the equipment and the peripheral instrumentation flow or pressure switches are functional.

- Measure the organic content in the washed / dewatered grit over a fixed period benchmarked on seasonal and historical or literature values.
- Measure the grit content in the overflow from the grit washing system over a fixed period benchmarked on seasonal and historical or literature values.

**M02.16.4**      Before Expiry of the Defects Liability Period

The Employer's Agent or Employer's Representatives 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 to the Employer's Agent or Employer's Representatives within 14 days after the inspection.

**M02.17**      **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.

**M02.18**      **OPERATION AND MAINTENANCE MANUAL SUMMARY**

The Contractor shall hand over to the Employer's 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.

**M02.19**      **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, they shall 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 their responsibility for the correctness of the drawings.

## **M02.20 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:

### **M02.20.1 General**

The following items shall be included in the rates:

- (a) Supply of all design and pre-manufacture documentation and obtaining approval thereof;
- (b) Procurement/manufacture of required equipment with associated equipment items and delivery to Site;
- (c) Installation of complete required equipment with associated equipment items and testing;
- (d) Services required during period of initial use before handover to the Employer.
- (e) 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. A further training requirement shall be allowed for as specified in the scheduled items.

### **M02.20.2 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.

### **M02.20.3 Installation, Testing and Commissioning of the Equipment**

<u>Item</u>	<u>Unit</u>
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.

M02.20.4 **Trial Operations**

<b><u>Item</u></b>	<b><u>Unit</u></b>
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 trail operation.

M02.20.5 **Employer's Operator Training**

<b><u>Item</u></b>	<b><u>Unit</u></b>
Training .....	No

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.

M02.20.6 **Spares Equipment**

<b><u>Item</u></b>	<b><u>Unit</u></b>
Spares.....	No

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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