

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
M08: MECHANICAL GEARBOXES



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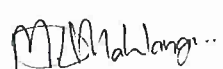


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PARTICULAR SPECIFICATION: M08: MECHANICAL GEARBOXES

CONTENTS

M08.1	SCOPE	4
M08.2	INTERPRETATIONS	4
M08.2.1	Definitions	4
M08.2.2	Abbreviations	4
M08.2.3	Standards	6
M08.2.4	Other Particular Specifications	6
M08.3	GENERAL DESIGN PARAMETERS	7
M08.4	SPECIFIC DESIGN PARAMETERS	8
M08.4.1	Gears	9
M08.4.2	Service Factor	9
M08.4.3	Bearings	9
M08.4.4	Lubrication	10
M08.4.5	Gearbox / Motor Coupling	10
M08.4.6	V-belt	10
M08.4.7	Flexible Couplings	10
M08.4.8	Housing	11
M08.4.9	Shaft	11
M08.5	FASTENERS	11
M08.6	MATERIAL OF CONSTRUCTION	13
M08.7	RECOMMENDED SPARES AND SPECIAL TOOLS	13
M08.8	GUARANTEE OF PERFORMANCE	13
M08.9	CORROSION PROTECTION	13
M08.10	COLOUR CODES	14
M08.11	QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE	14
M08.11.1	General	14
M08.11.2	Material Tests	15
M08.11.3	Type of Tests	15
M08.11.4	Quality Control Records	15
M08.11.5	Substandard Quality Control	16
M08.11.6	Access for Surveillance	16
M08.11.7	Manufacture	16
M08.11.8	Installation	16
M08.12	SYSTEM PERFORMANCE	17
M08.12.1	Works testing:	17
M08.12.2	Before commissioning	17
M08.12.3	During Commissioning	17
M08.13	BEFORE EXPIRY OF THE DEFECTS LIABILITY PERIOD	17
M08.14	EQUIPMENT TRAINING PROCEDURE	17
M08.15	OPERATION AND MAINTENANCE MANUAL SUMMARY	18
M08.16	DRAWINGS	18
M08.17	INTERCHANGEABILITY	18

M08.18	MEASUREMENT AND PAYMENT	19
M08.18.1	General	19
M08.18.2	Supply and Delivery to site with Documentation	19
M08.18.3	Installation, Testing and Commissioning of the Gearbox Equipment	19
M08.18.4	Trial Operations	20
M08.18.5	Employer's Operator Training.....	20
M08.18.6	Spares	20

M08.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, off-loading installation, test and commissioning of complete Gearboxes. The Specification shall be read in conjunction with the Project Specification and other relevant Particular Specifications.

M08.2 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.

M08.2.1 Definitions

For the purpose of this Specification the following definitions are used:

- 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

M08.2.2 Abbreviations

In this Specification the following abbreviations will 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 Engineers
ASME	: American Society of Mechanical Engineers
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
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)\

M08.2.3 Standards

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

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 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
ISO 281	: Rolling bearings -- Dynamic load ratings and rating life
BS 4999-141	: General requirements for rotating electrical machines. Specification for standard dimensions
SIS 05 59 00	: Pictorial Surface Preparation Standards for Painting Steel Surface

M08.2.4 Other Particular Specifications

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

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M01: Particular Specification for Screening Equipment

M02: Particular Specification for Degritter Equipment
M03: Particular Specification for Primary Tanks
M05: Particular Specification for Sludge and Wastewater Mixing Equipment
M05: Particular Specification for Surface Aerator Equipment
M09: Particular Specification for Archimedean Screw Pumps
M10: Particular Specification for Secondary Clarifier Tanks
M15: Particular Specification for Filter Belt Press Equipment
M16: Particular Specification for Conveyor Equipment
M17: Particular Specification for Actuators
M20: Particular Specification for Valves
M34: Particular Specification for Sluice Gates, Adjustable Weirs
M36: Particular Specification for Diffused Aeration Equipment
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 11: Automation and Control Design Standards Temperature Measurement
Volume 23: Automation and Control Design Standards Pressure Measurement

M08.3

GENERAL DESIGN PARAMETERS

The gearbox or speed reducer 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;
- 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,
- 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 the published statutory codes and legislation;

- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions; and
- The minimum availability of the equipment shall be 99 %.

M08.4

SPECIFIC DESIGN PARAMETERS

The Tenderer shall submit with their Tender a catalogue of the make of gearbox offered and indicate how the selection of gearboxes was made.

Unless otherwise stated, the gearboxes shall be directly mounted to the motor. The gears shall be helical gears which are used in applications with high speeds, large power transmission and low noise levels.

Gear drives shall be sized to ensure that the running load peak does not exceed the endurance limits of the components.

Gearboxes shall have an efficiency of not less than 96% on two stage reduction and 95% on three stage reduction.

Simple cooling may be by convection from the gearbox casings but without assistance from cooling fins or fans. Adequate other cooling means shall be provided as applicable. The exterior of the gearbox shall be free from dust or moisture traps. Access for inspection purposes shall be allowed for in the design of the gearbox casing. Maintenance free oil lock seals on the high speed shafts shall be a standard design feature.

The tenderer shall provide with his tender all information on oil circulation for gearboxes that incorporate the use of oil circulating pump.

A stainless-steel ball valve and extension drainpipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform. The drain provision shall be a rigid design with due consideration to handling, installation and maintenance activities. The baseplate shall be design such that the driving shaft is accessible for inspection, while at the same time allow access to the drainage pipe, without decommissioning and dismantling the gearbox from the transmission assembly.

Where the lubrication system requires the use of an oil pump then the circulation system will be fitted with an oil flow detection system/ device such as an oil flow switch in order to ensure gear protection when operational by detecting any no flow or low flow conditions which shall further be monitored on the works SCADA system. The oil flow detection system shall be capable of switching off the drive unit in the least time as recommended by the original gearbox Manufacturer.

The bearing span shall be suitably selected for vertical gearbox application and shall promote shaft support for the intended application. Rigid lateral load distribution shall be by means of a standardized pinioned arrangement reducing noise and vibration.

A rigid half coupling shall be shrunk onto the output shaft of the gearbox and shall be secured by an additional keep plate and bolted connection in a recognised manner.

Substantial eye bolts shall be provided for all reasonable lifting purposes.

The gearboxes shall carry the manufacturer's identification details together with the rated shaft speeds, rated shaft torque, output power and maximum ambient operating temperature.

The gearboxes shall conform to the relevant British Standards and AGMA ratings with respect to the following requirements:

- (a) The design ambient temperature shall be 45°C unless otherwise specified in the project specification.
- (b) The noise at 100% of the full output power and 45°C ambient shall not exceed 75 dBA as measured 1 m in distance from the equipment.
- (c) The gearing shall give double the life of the bearings when subjected to similar loadings.

The design of the gearbox shall be such that the following calculation shall be adhered to: -

$$\frac{\text{Actual Radial Load}}{\text{Permissible Actual Radial}} + \frac{\text{Actual Axial Load}}{\text{Permissible Axial Load}} \text{ shall be } \leq 1,0$$

Calculations shall be submitted. Failure to do so may render the Tender invalid.

M08.4.1 Gears

The gears shall be high efficiency case hardened helical gears and rated in accordance with the AGMA Code of Practice 420.04 for continuous operation.

Semi-hardened and subsequently machined gears will not be accepted.

M08.4.2 Service Factor

The minimum service factors indicated in the table below shall be based upon the installed power unless otherwise specified in the project specification: -

Process Units	Service Factor
Rotating Bridges: Sedimentation & Clarifier Tanks	1.5
Rotating Scraper System: WAS Thickeners, Primary Sedimentation & Fermentation Tanks	1.75
Aerators	2.25
Mixers	2
Screw & Plunger Pumps	2.25
Centrifugal and Positive displacement Pumps	2
Turbo Centrifugal Blowers	2.25
Dosing Pumps	2
Mechanical Screens	2
General speed reducing applications	2

M08.4.3 Bearings

Roller bearings shall be used throughout. Taper roller bearings shall be used to sustain radial and thrust loads. Bearings shall be designed for a design life in excess of the indicated hours in the table below, in accordance with ISO.281. Bearings for the output shaft shall be designed to withstand bending, up thrust, down pull and radial loads imposed by the equipment being driven. Tenderers shall indicate what

these forces are and how these shall be accommodated.

The Contractor shall ensure the lubricant used for the initial filling and specified in the maintenance manual, is adequate for prolonged operation in ambient temperatures of up to 45°C without overheating.

Process Units	Design Life	Operation
Rotating Bridges: Sedimentation & Clarifier Tanks	L10 for 100 000	Continuous
Rotating Scraper System: WAS Thickeners, Primary Sedimentation & Fermentation Tanks	L10 for 100 000	Continuous
Aerators	L10for 100 000	Continuous
Mixers	L10 for 100 000	Continuous
Screw & Plunger Pumps	L10 for 100 000	Continuous
Centrifugal and Positive displacement Pumps	L10 for 100 000	Continuous
Dosing Pumps	L10 for 100 000	Continuous
Mechanical Screens	L10 for 100 000	Continuous

M08.4.4 Lubrication

The gearboxes shall be constructed with a dry well for the low speed shaft bearing to avoid complete drainage of oil in the event of an oil seal failure. Provision to monitor the oil level must be provided. The bearing shall be grease lubricated with the greasing point easily accessible, where greasing point are not accessible due to gear orientation / auxiliaries attached to the gearbox, stainless steel extension pipes shall be used to ensure that points are accessible, the position of the extended grease lubrication points shall be subject to approval by the Employer's Agent / Employer's Representative. A stainless-steel ball valve and extension drainpipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform.

M08.4.5 Gearbox / Motor Coupling

The coupling shall be fully rated to transmit the motor full load power and tested to prove static and dynamic balance. The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. All coupling shall be suitable for standard motor IEC dimensioning (universal gearbox connection). The coupling shall be enclosed in a stationery solid-plate guard to the Employer's Agent / Employer's Representative satisfaction.

M08.4.6 V-belt

V-belts shall be designed to withstand the high tension and high-power drives, shall be long wearing, tough and trouble free. The V-belt cover shall be oil, heat and ozone resistant in order to protect the inner components. The compression section shall provide excellent gripping action and a high coefficient of friction but shall also allow an initial start-up clutching action in order to eliminate power spikes and excessive bearing loading. The moulded cogs shall provide optimum flexibility with minimal build-up of heat.

M08.4.7 Flexible Couplings

Flexible couplings consist of two types: gear type and multiple disc/diaphragm type. The gear type uses gear teeth to make them flexible and is either grease lubricated,

or oil lubricated depending upon their size. Diaphragm couplings do not require any form of lubrication and the flexibility is created by a series of multiple discs or a diaphragm made of spring steel and flexes as the shaft rotate.

Misalignment of the coupling is to be prevented by proper alignment of the coupling by means of a taper gauge or set of feeler gauges and a straight edge or dial indicator. Two types of misalignments are encountered by flexible couplings: Angular misalignment and parallel misalignment. Any adjustment to correct the misalignment in one direction may affect the other direction and both the angular and parallel alignment shall be checked after each adjustment.

A periodic check of the coupling alignment shall be performed as recommended by the Original Equipment Manufacturer during commissioning, testing and trial operation as specified in the project specification.

M08.4.8 Housing

The gearbox shall be manufactured of high strength cast iron which enables the gearbox to be used in harsh environments. The gearbox housing design shall incorporate a breathing plug and means of checking oil level.

All gearbox with a mass more than 25kg shall have lifting hooks or eyes integrally cast on the housing. All gearbox with a mass greater than 100 kg shall either have two removable eye bolts of the required strength securely attached to the valve body or lifting eyes forming an integral part of the valve body to facilitate easy handling during transport and installation

The breather plug shall be designed to effectively prevent pressure build-up inside the gearbox and also prevent dust and moisture ingress. Breather unit allowing continued oil spillage due to the overfilling of the gearbox shall not be accepted.

Oil level sight glasses (fully protected and UV resistant) shall be provided with levels marked for running and filling minimum and maximum positions respectively. These shall be arranged for easy viewing and shall take into account the angle of the gearbox mounting to ensure that the correct oil level in the gearbox is always visible. The filler cap and drain plug must be easily accessible without the need to remove any other part of the gearbox or connected equipment such as motor and belt drive covers & pulleys to get access to it. All gearboxes with motor of 110kW and above shall be provided with oil level protection. The design and installation configuration of the level protection shall be submitted to the Employer's Agent or Representative for review and acceptance.

M08.4.9 Shaft

The Input and output shafts shall be of sufficient dimension in order to avoid excessive torsional or bending stresses and deflection. The driven equipment (e.g. impeller) shall be secured to the shaft in such a way that it can be readily removed without any damage to the equipment or the shaft.

The shafts shall be protected by replaceable sleeves manufactured from non-corrosive material. The shaft shall be manufactured from stainless steel.

M08.5 **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 of stainless steel and 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 in 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.

M08.6 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>
Gears	High cast iron to BS 1542 Class 220 or an equivalent standard.
Pinions	AGMA 390.02 class 12.
Housing	Epoxy coated high strength cast iron
Input and output shaft	Stainless steel or similar approved
Oil drainpipe (external to the housing)	304L stainless steel
Oil level sight glass	UV and chemical resistant glass
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.	

M08.7 RECOMMENDED SPARES AND SPECIAL TOOLS

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

Tenderers must submit a provisional price (if requested in the Bill of Quantities) for a complete set of special 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.

M08.8 GUARANTEE OF PERFORMANCE

The Contractor shall guarantee the output and efficiency of all equipment, which guarantees shall be binding under the Contract. Where guaranteed performance is specified, certified test curves shall be drawn from the test data obtained from the purchased equipment and shall include efficiency (%), power consumption (kW), speed in rpm and speed/torque (rpm/kNm).

The Defects liability period shall extend over a period of 12 months calculated from the Completion as defined in the Contract Document. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Employer's Agent / Employer's Representative 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 not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification.

M08.9 CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection

M08.10 COLOUR CODES

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

M08.11 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

M08.11.1 General

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 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.

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

M08.11.2 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.

M08.11.3 Type of 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.

M08.11.4 Quality Control Records

Accurate and detailed quality control records shall be kept by the Contractor for all stages of the work.

All the quality control records shall be available for inspection by the Employer's Agent / Employer' Representative.

The collection of record documents for each item of Plant shall be collated and bound in a logical manner and retained by the Contractor as proof of quality achieved. These shall be available on demand for quality control and part payment releases.

The records shall be neatly filed and handed over to the Employer's Agent /

Employer' Representative. on completion of the work in the form of a Data Pack together with all relevant material and test certificates. Only after the Data Pack has been approved and signed off by the Employer's Agent / Employer' Representative. shall Plant be dispatched to Site.

M08.11.5 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.

M08.11.6 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.

M08.11.7 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.

M08.11.8 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.

M08.12 SYSTEM PERFORMANCE

M08.12.1 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's Representative for verification or when the QCP's require intervention or hold points for inspection.

Gearboxes shall be subject to testing using the selected project motors for at least 12 hours before dispatch to site. All results shall be available 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.

M08.12.2 Before commissioning

- Check for correct oil level in gearboxes
- Ensure all HD bolts are torqued down correctly.
- Ensure the output shaft is rotating in the correct direction.
- The alignment and levelling of each assembly shall be checked, and the results shall be available for inspection by the Employer's Agent / Employer' Representative.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

M08.12.3 During Commissioning

- Ensure all oil pumps. Temperature, level, flow or pressure switches are functional
- Vibration testing and benchmarking.
- Ensure that there no oil leaks or visible damages to the gearbox housing.

M08.13 BEFORE EXPIRY OF THE DEFECTS LIABILITY PERIOD

The Contractor has an obligation 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 within 14 days.

Should the first oil change (based on the original equipment manufacturers recommendation) occurs before the issuing of the certificate of completion of the gearbox equipment to the Employer. The Contractor must carry out the first oil change in each gearbox. The drained oil shall be sieved and inspected for any contamination in the oil. In the event of any unusual contamination, (metal deposits etc) the Contractor, will take the necessary steps, to investigate the cause, and where required to replace and or repair the gearbox (s) at no cost to the employer.

M08.14 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.

M08.15 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.

M08.16 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.

M08.17 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.

M08.18 MEASUREMENT AND PAYMENT

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

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

M08.18.1 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 gearbox equipment with associated items and delivery to Site;
- Installation of gearbox equipment with associated 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.

M08.18.2 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 craning 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. Tender rate shall include any external oil filters, flow and pressure in their offer.

M08.18.3 Installation, Testing and Commissioning of the Gearbox Equipment

<u>Item</u>	<u>Unit</u>
Installation, Testing and Commissioning of the Gearbox 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's Representative), materials and Temporary Works necessary to completely install, test and commission and render fully operational gearbox 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 / Employer' Representative with a report recording any irregularities when cleaning the sieves after straining.

M08.18.4 Trial Operations

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

M08.18.5 Employer's Operator Training

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

M08.18.6 Spares

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