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PARTICULAR SPECIFICATION

M11: MECHANICAL FERMENTATION TANKS

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M11.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of the mechanical equipment for Fermentation Tanks. The Specification shall be read in conjunction with that of the Project Specification.

M11.2 INTERPRETATIONS

M11.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

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

M11.2.2 Standards

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

SANS 10400	: National Building Regulations
BS 5304	: Code of practice for safeguarding of machinery
SANS 9096-1: 1994	: Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	: Dimensions of ball bearings, cylindrical and spherical roller bearings
SANS 10162-4	: Structural use of Steel Part 4: The design of cold-formed stainless steel structural
SANS 10044-3	: Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10044-4	: Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders Working where weld procedure approval is not required.
SANS 10064	: The preparation of steel surfaces for coating
SANS 10102-4	: 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

M11.2.3 General Requirements

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

M01: Particular Specification for Mechanical Screens

M08: Particular Specification for Gearboxes

M12: Particular Specification for Elutriation Pumps

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 8: Automation and Control Design Standards Flow Measurement

M11.3 **DESIGN OF FERMENTATION TANKS**

M11.3.1 General Design Parameters

Fermentation Tanks shall be designed such that the following requirements are met:-

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs,
- To ensure safe and satisfactory operation for an acceptable life expectation of 12 years under the ambient conditions prevailing at the Site,
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum,
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution,
- To satisfy any specific requirement contained in the statutory codes and legislation, and
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.

M11.3.2 Specific Design Parameters

The objective of the fermentation tank is to ferment primary sludge and to maximise the production of Volatile Fatty Acids (VFA), specifically acetate and propionate. The goal is to convert 8-15% of the volatile solids to Volatile Fatty Acids (VFA). The fermenter and associated structures are to have special surface protection for acidic environments.

The fermenters are to be feed on a continuous or semi-continuous basis. The fermented sludge shall overflow back into the equalisation tank/biological reactor. For small plants two fermenters are required and four fermenters for large plants.

Design Loads:

- The primary sludge target consistency is 1.0 to 2.5% with regular (hourly) withdrawal from the primary sedimentation tanks.
- The primary sludge flow is based on the peak week (maximum 7 days running average) influent Total Suspended Solids (TSS) concentration.
- Sludge retention time must be flexible and operation time shall range from 2-6 days.
- The sludge fermenter is operated in an acidic environment, with a typical pH in the range of

5.2 - 5.8.

- The Hydraulic Design Loading is 90 kg/m²/day

M11.4 PRIMARY SLUDGE SCREENING

Primary sludge screening (3mm) may be required, depending on the main stream screening process. Sludge will be screened before sludge enters the fermentation tanks.

The screening of sludge occurs in order to remove large suspended or floating solids from raw wastewater to prevent subsequent plugging of pipes or damage to pumps. Refer to particular specification M37: Volume M37 for a detailed specification for Mechanical Sludge Screens.

M11.5 FERMENTATION TANK

M11.5.1 Fermentation Tank Parameters

The mechanical equipment to be supplied under this Contract shall be installed, tested and commissioned on concrete structures, constructed by others, to the dimensions indicated on the construction detail drawings.

The tank shall be circular with a conical bottom and a side water depth (SWD) of a maximum of 5 m unless indicated differently on the construction drawings. The peripheral wall shall be finished to 1 m above the finished terrace level. The floor of the tank shall be sloped, vertical to the horizontal 1:6, to assist the fine sludge being scrapped to a central collection hopper for withdrawal. The diameter of the tank shall be as shown on the civil construction drawings.

M11.5.2 Inlet Pipe

The inlet pipe shall have a minimum diameter of 350 mm unless specified otherwise in the Project Specific Specification or drawings and shall be manufactured with 304L SS, supplied and installed by the Civil Contractor.

M11.5.3 Access Bridge Parameters

A fixed access bridge shall be manufactured in 3CR12 and shall cover half the tank diameter. A 3CR12 ladder with the necessary handrails shall be rigidly fixed to the outer end of the bridge for access purposes.

- Designed Load: 2500N per square meter of walkway area
- Walkway: no less than 750 mm wide, 3CR12 stainless steel
- Open Grating: 3CR12
- Hand and knee rails: 3CR12 on both sides of walkway
- Kicker plates: 100 x 4.5mm 3CR12 attached to both sides of the bridge

The bridge shall be supported at the perimeter tank wall and by the centre support column.

M11.5.4 Walkway

The walkway shall be assembled by welding joints. The joints for the hand railing and walkway shall be welded after installation of the bridge.

M11.5.5 Fasteners

The torque drive shaft shall be connected to the gearbox/motor system by means of a bearing.

The gearbox/motor system shall be secured to the bridge by means of bolts.

M11.6 SCRAPER MECHANISM

M11.6.1 General

Where possible all adjusters shall be above the water level. A detailed drawing of the proposed mechanism shall accompany the Tender.

M11.6.2 Scraper Mechanism Parameters

The scraper mechanism shall scrape the full diameter of the tank. The scrapers shall be fitted to a centre 304L SS torque drive shaft and two 304L SS support frames. The support frames shall be joined together at the centre of the tank and supported by linking the frames to a centre drive torque cage.

No underwater bearings shall be permitted.

M11.6.3 Support Frames

The support frames are to be at least 6 mm in thickness. Support for the scrapers shall be of suitable angle or tubular construction and shall be of sufficient strength to withstand the loads imposed by the scrapers when moving in sludge that has reached a concentration of 6%.

The support structure shall be rigid in design and shall be fixed to a 304L SS centre drive torque cage, suspended from the drive unit output shaft or from a bearing on the bridge in a rigid manner.

M11.6.4 Scrapers

The scrapers shall be of Echelon type fitted with synthetic rubber squeegees shaped to fit snugly on the floor. The shape of the squeegees shall be such that at any point they will fit the curvature of the conical floor of the basin. Care must be taken to minimise the wear on the squeegees but no supporting wheels shall be considered

The overall height of the scraper shall be at least 300 mm, and the scrapers shall overlap by at least 10%.

M11.6.4.1 Fasteners

The squeegees are to be fitted to the scrapers by means of a back plate. The squeegees are to be secured 50 mm from the bottom of the scraper by means of a bolted connection. The bolt shall pass from the back plate, through the squeegees to the scraper. The squeegees back plate shall be 50 mm in height and have a minimum thickness of 4.5 mm.

M11.7 DRIVE CAGE

The 304L SS drive torque cage shall be required to transmit the power from the motor to the scraper mechanisms. The cage must be able to handle the transmission of torque imposed by the scraper mechanism without excessive deflection, thrust and the overhung moment due to hydraulic forces. The cage must also be designed stiff enough to limit vibration and deflection.

M11.7.1 Motor

The drive shaft shall be driven by a central, geared electric motor, secured to the bridge, through a speed reducer. Refer to Particular Specification E01: for a detailed specification for

the electric motors.

M11.7.2 Gearboxes

Refer to M08: Mechanical Specification for Gearboxes.

M11.7.3 Motor/Gearbox coupling

The coupling shall be fully rated to transmit the motor full load power and shall be tested to prove the above features together with static and dynamic balance. The motor shall be coupled to the gearbox input shaft with a direct flexible coupling.

M11.7.4 Protection

Suitable protection shall be provided for in the event of an obstruction causing the scraper operation to be interrupted. The protection provided shall interrupt the operation of the scraper thereby preventing damage to the motor and gearbox.

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

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

M11.8 **PICKET FENCE**

The picket fence shall be the full diameter of the tank. A row of 304L SS angle members spaced equally along the scraper radius shall be installed to create a picket fence attached to each of the scraper support frames. The members must be spaced at least 300 mm apart and must be of a length so that the free ends terminate approximately 500 mm below SWD.

Angle iron members forming the picket fence must be sufficiently rigid to withstand the loads imparted by movement through sludge without distortion when the concentration is 6%. The angles must be attached to the scraper support frame using a bolted bracket that allows the removal of individual members from the framework.

Angles must be fitted with the apex of the angle facing away from the direction of movement.

M11.9 **DESLUDGING PIPES (SUPPLIED BY OTHERS)**

The desludging pipe shall have a treated effluent purge connection and a blank flange 200 mm above the maximum water level in the tank, as to remove any blockages in the pipe. The desludging pipe shall be provided with long radii bends in order to limit potential of any blockages occurring within the pipes. The number of bends in the pipe is to be kept to a minimum and there are to be no reducers on the sludge draw-off pipe.

The desludging pipe shall have a minimum diameter of 200 mm, exit the tank from the bottom into a sludge sump where it shall be pumped to the Digesters.

M11.9.1 Desludging Valves (supplied by others)

The actuated rising spindle knife gate shall be installed on the desludging pipe work to control the flow of the desludging pipe. The frequency and duration of the valve opening shall be time controlled. This will be controlled by a Programmable Logic Controller (PLC) which shall be supplied and installed by others.

The knife gates with wetted parts shall be manufactured in 304 SS.

M11.10 OVERFLOW WEIR

A straight overflow weir made of 4,5 mm 304L SS plate 200 mm deep, shall be provided and installed on the outside of the internal concrete wall of the cantilever launder. The overflow weir shall be attached to the tank wall by means of 316 SS bolts.

After installation the effluent shall discharge freely and evenly around the whole circumference of the tank without leakage through the joint between the weir and the wall or the joints between weir sections.

Tenderers shall allow in their process for sealing against “off the shutter” concrete finish and between ends of weir sections with an approved material such as closed cell expanded neoprene. Holes in the weir plate shall be slotted to permit adjustment.

M11.11 FLOW METERS

Flow meters shall be installed as specified and shall conform to the requirements of the Automation and Control Design Standard Volume 8: Flow Measurement.

M11.12 PIPEWORK

The following shall be supplied and installed by others:-

- (1) The inlet under the floor and inside the inlet structure of the tank
- (2) The sludge draw-off pipe
- (3) The effluent pipe work

M11.13 SPARES AND TOOLS

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

Spares which the Client decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept available for no less than 15 years.

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

M11.14 PROOF OF MAINTENANCE

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

M11.15 BOLTS

Weir plates and steady bearings shall be attached to the tank using 316 SS anchors set in holes drilled by the Contractor under this Contract.

M11.16 METAL PREPARATION AND CORROSION PROTECTION

Refer to particular Specification G02: Corrosion Protection

M11.17 COLOUR CODES

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

M11.18 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

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

M11.18.1 Manufacture

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

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

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

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

M11.18.2 Installation

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

M11.19 SYSTEM PERFORMANCE

M11.19.1 Works testing

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

M11.19.2 Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be

available for inspection by the Engineer.

- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

M11.19.3 After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional

M11.19.4 After filling of the Tanks

Weirs

The even distribution of flow over the weirs and the absence of bypassing are to be ensured after commissioning.

M11.19.5 Before Expiry of the Defects Liability Period

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

M11.20 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, civil preparation, coring and grouting, etc. Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point.

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