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PARTICULAR SPECIFICATION

M10: MECHANICAL SECONDARY CLARIFIER TANKS EQUIPMENT

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M10.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of Secondary Clarifiers. The Specification shall be read in conjunction with that of the Project Specification.

M10.2 INTERPRETATIONS

M10.2.1 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

M10.2.2 Standards

All design standards for the secondary clarifier tanks 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 1044-3	:	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 10332	:	Homologation of tyres
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

M10.2.3 General Requirements

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

M08: Particular Specification for Gearboxes

M17: Particular Specification for Actuator equipment

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 8: Flow Measurement

M10.3 **DESIGN OF CLARIFIERS**

M10.3.1 General Design Parameters

Secondary Clarifiers 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.

M10.3.2 Specific Design Requirements

The objective of the clarifier tanks is to separate the biological solids in the mixed liquor from the treated effluent and to thicken the residual biological sludge for recycling to the BNR reactor. The clarifiers are to be downstream of the Biological reactors and upstream of the disinfection Contact tank.

There shall be no less than two tanks per reactor. The mechanisms of the thickeners shall be designed to operate at the most extreme loadings and be capable of restarting once stopped.

Design Loads:

- The worst case Diluted Sludge Volume Index (DSVI) = 135 ml/gm
- Mixed Liquid Suspended Solids (MLSS) in summer = 3000 mg/l
- Mixed Liquid Suspended Solids (MLSS) in winter = 5000 mg/l.
- Typical return activated sludge concentration is between 6000 to 15000 mg/l
- The maximum return activated sludge return is 20000 to 30000 mg/l
- Solid flux in summer is 50 kg TS/m²/day

- Solid Flux in winter it is 65 kg TS/m²/day
- The Average Hydraulic Loading rate: 0.6m³/m²/hr
- The Peak Hydraulic Loading rate: 0.8m³/m²/hr

Easy access to components subjected to wear such as gearboxes, bearings, driving wheels etc, is required.

Welds and fasteners

All stainless steel metals are to be welded together unless otherwise stipulated. All welds are to be in accordance with SANS 10044. 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 Engineer.

M10.4 CLARIFIER

M10.4.1 Clarifier Parameters

The 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 tank and a side water depth (SWD) of a minimum of 4,0 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 sludge being scrapped to a central collection hopper for withdrawal.

The diameter of the tank shall be as shown specified in Project Specific Specification or on the drawings.

M10.4.2 Inlet Arrangements to Clarifiers

M10.4.2.1 Centre Column

The centre column shall be designed to serve as the inlet to the clarifier tanks and a support structure for the centre pivot of the bridge. The centre column shall enter the tank vertically from the bottom and shall be constructed in reinforced concrete that shall form a pivot for the bridge, by a Civil Contractor.

The inlet effluent pipe shall enter the clarifier from the bottom, shall fit within the centre column and shall be manufactured from 304 L SS with a diameter of 800 mm and minimum wall thickness of 6 mm unless otherwise specified in the Project Specific Specification or drawings. The centre column shall form the flocculation baffle at a distance of 0.5 – 0.6 times the SWD from the top of the clarifier. The top of the inlet pipe shall be closed and suitably protrude above the liquid level to horizontally support the bridge structure. The inlet pipe shall be supplied and installed by the Civil contractor.

M10.4.2.2 Influent Well

An influent well with a minimum diameter measuring at least 0.14 times that of the clarifier diameter shall be installed. The depth shall be at least 0.33 times that of the side wall depth (SWD). The well shall protrude 500 mm above the maximum liquid level within the tank.

At least six hinged gate openings with a width to depth ratio of 2:1, positioned at the top, in the side wall of the influent well shall be provided for influent discharge. The opening angle between the gate and influent well wall shall be 30°. The direction in which the hinged gates

open shall oppose the direction of rotation of the bridge supporting the floor scrapping mechanism. The well and gate openings shall be manufactured from minimum thickness 4,5 mm 304 L stainless steel sheet metal. The influent well shall be suitably supported and secured from the inlet pipe work.

The Tenderer shall be responsible for the design and detailing of all members, support members, gussets, plates and stiffeners of the inlet arrangement as described above. A detailed drawing of the proposed mechanism shall accompany the Tender show all member sizes designed for.

M10.4.2.3 Flocculation Baffle

The diameter of the flocculation baffle shall be between 0.15 and 0.2 times that of the tank diameter with a depth of 0.5 - 0.6 of the SWD.

The flocculation baffle shall have a double baffle design in order to increase the mixing intensity and retention in time. The retention time shall be 10-20 minutes at nominal design flow. The mixing intensity selected to achieve bio-flocculation of Mixed Liquid Suspended Solids shall be in the range of $G = 30 - 70$ / sec.

The flocculation baffle shall be manufactured in concrete (by others) unless specified otherwise in the Project Specific Specification.

However the inlet dissipation "ears" shall be supplied as part of the mechanical scope of work and be manufactured from 304 stainless steel.

M10.4.3 Access Bridge Parameters

The rotating access bridge shall be manufactured in 3CR12 and shall cover at least three quarters. The bridge shall be supported by a hinged bearing on the inlet structure and by driven wheeled support on the perimeter wall of the tank (peripheral drive). A 3CR12 ladder with the necessary handrails shall be rigidly fixed by means of welds to the outer end of the bridge for access purposes.

- Designed Load: 2500N per m² of walkway area
- Walkway: no less than 750 mm wide, 3CR12 stainless steel
- Open Grating: 3CR12
- Hand and kneerails: 3CR12 on both sides of walkway
- Kicker plates: 100 x 4,5mm 3CR12 attached to both sides of the bridge

The bridge shall be designed to resist any torsion imposed by the scraper mechanism without excessive deflection.

The bridge shall furthermore be designed with sufficient camber to completely cancel the deflection which will be produced by the dead load of the complete bridge with the scraper mechanism attached, the latter unsubmerged.

M10.4.3.1 Walkway

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

M10.4.3.2 Fasteners

The hinged bearing and base plate structure shall be manufactured from 3CR12 and shall be designed as to withstand the maximum design load of the bridge. Roller bearings shall be used to pivot the bridge. The bearings are to be water resistant.

M10.4.4 Motor

The bridge shall be driven by a slip ring electric motor through a speed reducer giving a peripheral speed of approximately 2 to 3 meters per minute. The minimum rating of the motor shall be 0.75 kW. Refer to Particular Specification E01: for a detailed specification for the Electric Motors.

M10.4.5 Gearbox

Refer to Particular Specification M08: for a detailed specification for the gearbox.

M10.4.6 Gearbox / Motor Coupling

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

M10.4.7 Protection

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

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.

M10.4.8 Wheels

At least two 125 mm wide polyurethane tyred wheels must be used for the bridge. The wheels are to be secured to the bridge by means of welds. The wheels must be accurately aligned so that the plane of rotation is normal to a line drawn through the pivot of the wheel and the centre point about which the bridge rotates, so as to minimise wear of the tyres.

The driving wheels shall be fitted with a 3CR12 protective cover, which shall be fitted to the end of the bridge, and provided with a front mounted adjustable guard that will push foreign objects off the wall and to the outside thereof. Wheel guards shall be easily detachable and not form part of the supporting structure.

The underside of the rotating bridge and the underside of the backing plates for the rubber scrapers shall have sufficient clearance to prevent any touching between metal and concrete when the tyres are worn down. The spacing of the wheels shall be such as to give adequate lateral stability to the bridge under all operating conditions. All lubricating points on the driving mechanisms and wheels shall be accessible and such that no grease is deposited on the concrete surface on which the wheels run.

M10.4.9 Drive Train

The design of the drive train shall be such that no slippage occurs, under the maximum design load or during wet weather under 1, 5 x normal operating load, between the driving wheel and the riding surface that will consist of steel trowelled concrete.

M10.5 SCRAPER MECHANISM

M10.5.1 General

No underwater bearings shall be permitted. Where possible all adjusters shall be above the water level. A detailed drawing of the proposal mechanism shall accompany the Tender.

M10.5.2 Scraper Mechanism Parameters

The scraper mechanism for the Clarifier shall consist of full diameter of the tank to scrape the entire floor area. The scrapers shall be fitted to an underwater support system manufactured from 304L stainless steel, which shall be suspended from the overhead rotating bridge.

The scraper mechanism and the bridge shall form one rigid unit on the side of the pivot point with an allowance of at least 30 mm vertical adjustment in the level of the floor scraper.

M10.5.3 Scrapers

The scrapers shall be of spiral ('C' formation) type and shall be fitted with synthetic rubber squeegees shaped to fit snugly on the floor. The shape of the squeegees shall be such that at any point it 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%. Near the central column the scrapers shall form a spiral in order that the sludge is scraped constantly into the hopper at any bridge position.

M10.5.3.1 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 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. Refer to PAE 3.2 for weld specifications.

M10.5.4 Back Plates

The back plates shall be angled more than 60° to the radius, and be manufactured from 304 stainless steel with a minimum thickness of 6 mm.

The underside of the backplates shall be such that at any point it 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.

M10.5.5 Structural Units

The cross-braced structural units suspending the scrapers from the bridge shall be sufficiently sturdy to keep the scrapers in their relative positions without the metal back plates coming into contact with the floor. The structural units are to be manufactured from 304 stainless steel.

The contractor shall be responsible for the estimated loading on the structure and the torque calculations required to design his equipment under specified maximum loads and shall utilise a factor of safety of not less than 1,5 in the selection of the drive and structural design components.

M10.6 DESLUDGING PIPE (SUPPLIED BY OTHERS)

The de-sludging pipe is to have a compressed air purge connection and a blank flange 200 mm

above the maximum water level in the tanks, as to remove any blockages in the pipe. The de-sludging pipes shall be provided with long radii bends in order to limit potential 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 de-sludging pipe shall slope towards the scum removal pipe, joining up with it.

M10.6.1 De-sludging Valves (supplied by others)

Continuous sludge removal shall be due to the differential hydraulic head (1.5m minimum) controlled by a manually operated underflow knife gate valve.

The knife gate valves are to be manufactured from 304 SS.

M10.7 **SCUM REMOVAL MECHANISM**

M10.7.1 General

Where possible all adjusters shall be above water level. The tank shall be de-scummed on each rotation of the scraper bridge.

A detailed drawing of the proposed mechanism shall accompany the Tender.

M10.7.2 Scum Board

A manufactured scum board of 3CR12 plate with a minimal dimension of 450 mm deep, 300 mm below surface water level shall be provided along the perimeter of the overflow weir at a distance of 300 mm from the weir and supported by 304 stainless steel brackets.

M10.7.3 Scum Skimmer Plate

A scum skimmer plate shall be provided at least 3 mm thick of 304 stainless steel and 150 mm deep to skim the water surface area within the scum baffle (including the stilling chamber) and a scum receiving hopper shall be provided. The scum skimmer shall be set at an angle to the bridge and supported at short intervals to prevent buckling. The part of the scum skimmer passing over the hopper shall be pivoted and shall be arranged in such a way that it will lift clear of the hopper. The skimmer plate will be fixed to the support structure by welds.

M10.7.4 Stamford Baffle

The horizontal width of the baffle shall be calculated based upon the following:

Width = $460 + 17 \times (\text{clarifier diameter in metres})$

The maximum horizontal width of the baffle shall be less than or equal to 1200 mm and the baffle shall be installed at an angle of 45°. The baffle shall be manufactured from 304 stainless steel.

M10.7.5 Scum Box

The scum box opening shall measure at least 1200 mm in a radial direction and 500 mm in the direction parallel to the overflow weir and shall be made from 3CR12 plate 4,5 mm thick. It shall be equipped with a gently sloping beach, sloping from a height of 300 mm to a height of 500 mm, with a length of 500 mm and a width of 1150 mm. The scum is then deposited in the collection trough which slopes towards the scum discharged pipe. The hopper shall be supported on the side wall of the tank and shall have sufficient cross bracing to ensure rigidity.

A 3CR12 projecting striker arm shall activate a 304 L stainless steel valve, which shall open for

a period of between 20 – 40 seconds during the period that the scraper arm is above the hopper. The valve shall preferably consist of a weighted bung capable of shutting off the discharge pipe.

A manual scum pipeline valve shall also be required.

The scum box shall have a positive hydraulic scum removal action and shall be positioned facing the prevailing wind. The direction shall be specific to the works of installation.

M10.7.6 Scum Discharge Pipe

The scum discharge pipe from the hopper shall have a diameter of at least 200 mm be and manufactured from 6 mm thick 304L stainless steel. It shall slope towards the scum discharge manhole.

M10.8 **OVERFLOW WEIR**

A V - notched single overflow weir manufactured of 4,5 mm 3CR12 plate 200 mm deep shall be provided and installed on the outside of the internal concrete wall of the launder. The overflow weir is to be attached to the wall of the tank by means of bolts.

The installation of the V-notched shall ensure that the effluent discharges 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.

Effluent Launder and launder Covers

To minimise algae growth the maximum width of the launder shall be 450 mm.

Where specified in the project specific specification the tenderer shall include for effluent launder covers. The covers are to be manufactured from GRP and any supports shall be manufactured from 304 stainless steel. The launder section cover over the outlet pipe in the launder shall be either removable or hinged to facilitate inspection of the outlet pipe. The final design shall be approved by the Engineer prior to manufacture.

M10.9 **PIPEWORK**

The following supply items will 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 pipework

The contractor under this Contract must, however, supply and install the scum discharge pipe up to the scum discharge manhole adjacent to the tank, which will be built by the Civil Engineer.

M10.10 **SPARES AND TOOLS**

The Tenderer must submit on the appropriate schedule a priced list of spare parts which it is recommended should be kept by the Water treatment Plant for maintenance of the plant. Spares which the Management decides to order must be manufactured simultaneously with the

rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

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

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

M10.11 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

M10.12 BOLTS

Weir plates and scum baffles shall be attached to the tank using 316 stainless steel anchors set in holes drilled by the Contractor under this Contract.

M10.13 METAL PREPARATION AND CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection.

M10.14 COLOUR CODES

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

M10.15 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

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

M10.15.1 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.

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

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

M10.15.2 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 requested to attend certain stages of completion of installation to ascertain compliance with the Specifications and

to witness the Contractor's site inspections at the Engineer's discretion.

M10.16 SYSTEM PERFORMANCE

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.

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.

M10.16.1 Prior to Filling of the Tanks

M10.16.1.1 Driving Wheels

During the above tests the concrete surface under the driving wheels shall be thoroughly wetted.

After Initial Commissioning

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

M10.16.2 After filling of the Tanks

M10.16.2.1 Weirs

The even distribution of flow over the weirs. Absence of by-passing.

M10.16.2.2 Scum removal

Positive removal of scum

M10.16.3 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

M10.17 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point. The respective tender rates shall cover all costs from supply to commission of each degritter system but excluding the electrical power supply and electrical cable connection.

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.