



**CONTRACT NO: RLM/RWST/OMM/0103/2024/25 – RE-ADVERT:
UPGRADING AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS - MECHANICAL AND ELECTRICAL WORKS**

CONTRACT NO: RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: APPOINTMENT OF A CONTRACTOR FOR THE UPGRADING AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

VOLUME 3: PARTICULAR SPECIFICATIONS

JULY 2025

NAME OF BIDDER:

BID PRICE: (VAT Incl.)

Prepared by:

**RUSTENBURG WATER SERVICES TRUST
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RUSTENBURG
0300**

BID CLOSING: 01 August 2025 at 10:00

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

GROUPED WATER SANITATION INFRASTRUCTURE UPGRADE PROJECTS

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

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RUSTENBURG WATER SERVICES TRUST

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**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT
WORKS – MECHANICAL AND ELECTRICAL WORKS**

C3.4.2 CONSTRUCTION OF MECHANICAL WORKS

C3.4.2.2 PARTICULAR SPECIFICATIONS FOR MECHANICAL WORKS

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



C3.4.2.2 PARTICULAR SPECIFICATIONS FOR MECHANICAL WORKS

List of applicable Particular Specifications:

- PPG : Contractors Establishment on Site and General Charges
- PTB : Dissolved Air Flootation Equipment
- PTT : Rapid Gravity Filters
- PTTG : Granular Activated Carbon Filters
- PTG : Granular Activated Carbon Media
- PTO : Ozone Equipment
- PT : Pumps
- PTU : Chlorine Dosing Equipment
- PLC : Chemical Dosing Equipment
- PTN : Sludge Dewatering Equipment
- PLQ : Corrosion Protection for Steel Pipes
- PLN : Manufacturing of Steel Pipes
- PLK : Manufacturing and Supply of Valves
- PLT : On-line Flow Meters
- PTP : Hoisting Equipment
- PTW : Electrical Actuators
- PTY : Conveyor Equipment

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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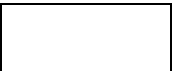
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**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

**PPG: CONTRACTOR’S ESTABLISHMENT ON SITE
AND GENERAL CHARGES**

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Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

PPG CONTRACTOR'S ESTABLISHMENT ON SITE AND GENERAL CHARGES

PPG 1 SCOPE

This Specification covers all work and costs involved in the establishment of the Contractor's organisation, camp and plant on the site and the removal thereof after completion of the Contract. The Specification also covers the Contractor's general obligations, liabilities and risks not covered elsewhere but generally applicable to all contracts.

The specification also covers any/all additional requirements not covered elsewhere.

PPG 2 CONTRACTOR'S OFFICES AND STORES

The Contractor shall supply and maintain during construction adequate administrative and safe storage facilities on site for the proper execution of the Contract as may be required.

Any/all ablution facilities provided on site for use by the Contractor's personnel shall comply with the regulations of the local authority and shall be maintained in a clean and sanitary condition to the satisfaction of the Engineer.

On completion of the Works or as soon as the facilities provided by the Contractor are no longer required, the Contractor shall remove such facilities from such, clear away all surface indications of their presence in re-instate the area of the site camp to its original condition as far as possible.

The Contractor shall be responsible to maintain adequate security on site for the duration of installation and commissioning up to the issue of a Taking-Over Certificate in line with the requirements of the Contractor's Insurers. The Contractor shall put in place such security to look after and protect all equipment and plant to be supplied and installed under this Contract, including any temporary works as well as the Contractor's site establishment.

PPG 3 FACILITIES FOR THE ENGINEER

Unless otherwise specified, the Engineer and his representatives do not require any office facilities on the site of the Works for the duration of construction.

PPG 4 SERVICES

The provision of any/all services such as water and electricity required for the contractor's site establishment or for construction purposes shall be the responsibility of the Contractor.

The availability of potable water and electricity at the site of the Works shall be confirmed at the tender briefing meeting. If available, the Contractor shall be responsible under the Contract for the relevant connections and distribution at his Cost of all water and electricity that he may require for purposes of construction, testing and commissioning of the Works. Accordingly, the Contractor shall pay all consumption charges, and, at his cost, provide all connections, consumption meters, pipework, storage tanks, cabling, transport and other items associated with the supply of water and electricity for construction activities. All connections to Employer's supply system shall be in accordance to the Employer's or local authority's standards and bylaws and approved by the Engineer. The tariff payable for water and electricity shall be confirmed at the tender briefing meeting.

In terms of access roads, the Contractor shall be responsible to repair any damage to access roads to the Site used during construction and for the purposes of this Contract and the road shall be left in a similar state as it was when the installation on Site commenced. Any/all costs in this regard shall be for the Contractor's account and deemed to have been included in the tender.

PPG 5 NOTICES, SIGNS AND ADVERTISEMENTS

The Contractor shall not erect any notices, signs or advertisements on or near the Site without the written approval of the Engineer.

If so specified and measured in the bills of quantities, the Contractor shall erect the official nameboard(s) of the Contract in terms of the drawings at the location(s) indicated by the Engineer.

All signboards, notices, the official nameboard(s) and any advertisements shall be removed by the Contractor on completion of the Works.

PPG 6 ADDITIONAL REQUIREMENTS

If so specified, the following additional requirements shall apply during the construction period, commissioning period or the defects notification period as defined in the General Conditions of Contract. The Contractor shall be expected to provide the following additional services during the stated period for which allowance shall be made under the relevant payment items.

PPG 6.1 Site visits and reporting

The Contractor, or a designated agent approved by the Engineer, shall be expected to visit the Works the number of times stated in the Project Specification per calendar month during the period stated in the Project Specification to assess the condition and performance of the plant. The purpose of these visits shall be the conditional assessment of all mechanical, electrical, control and monitoring equipment installed under the Contract, recording the necessary flow data and motor run hours and taking of the prescribed water quality samples as well as discussion with the full-time operators regarding any process or plant-related matters. The Contractor shall submit a formal report after each and every site visit to the Engineer and the Employer. The format of such report shall be discussed and agreed during the trial operation period.

PPG 6.2 Water quality sampling

The Contractor shall employ the services of an accredited laboratory to take samples at prescribed locations at the Works for analysis. Composite and/or grab samples shall be taken as specified in the Project Specifications for the specified period and shall preferably coincide with the Contractor's, or designated agent's, site visit as described above.

PPG 6.3 Maintenance and servicing of Mechanical and Electrical equipment

The Contractor shall maintain all mechanical and electrical equipment installed under the Contract for the period and duration as specified in the Project Specifications and shall supply all labour, tools, materials, lubricants, oil etc in order to ensure that the equipment remains fully functional for the said period in accordance with the supplier's maintenance instructions.

The Contractor shall also allow for a full service all equipment installed under this contract at the end of the defects liability or notification period by the respective supplier or its designated agent and a service report for each item of equipment serviced shall be submitted to the Engineer once completed.

All flow measuring and water quality monitoring equipment shall be calibrated every 3 months and at the end of the defects liability or notification period and the Contractor shall submit documentary proof of such calibration to the Engineer for approval.

The cost of the replacement, repair or adjustment of any item of equipment that is deemed a defect or due to poor manufacturing or workmanship shall be for the Contractor's account as per the normal provision of the Contract.

Any replacement or repair that is deemed a result other than a defect may be sourced from the pool of available spares upon confirmation by the Engineer, provided as free-issue equipment by the Employer or purchased by the Contractor upon receipt of a written instruction from the Engineer.

Unless otherwise specified, all equipment supplied under this Contract shall be **serviced** and **tested on site** at the end of the Defects Notification Period, to prove that it complies with the Specifications prior to the issuance of the Performance Certificate signifying final completion and acceptance of the Works.

PPG 6.4 Supply of chemicals

The Contractor shall supply and uphold all chemicals required for the operation of the Works for the period and duration specified in the Project Specification. This shall include all poly-electrolyte used for dewatering of sludge (if applicable), chlorine, lime and any/all iron salts and any/all reagents required by water quality monitoring instruments. The Contractor shall also supply the first charge of diesel required for the standby generator.

The estimated quantity of chemicals for tendering purposes shall be stated in the Project Specifications.

Important note: This provision shall remain in force until the amount of chemicals allowed for in tender has been reached.

PPG 6.5 Guarantees

In the event that any of the additional services are required after the issuing of the Taking Over Certificate, the Contractor shall submit a separate guarantee for the execution of such additional services in the form of a dedicated performance guarantee to the value of the tendered amount for such tasks. This guarantee shall be issued to the Employer before the Taking-Over certificate will be issued and the Contractor shall make adequate allowance in his tender price under payment item PPG 8.5.5 for upholding the guarantee during defects notification period. The guarantee shall be returned to the Contractor at the end of the said period with the Performance Certificate once all contractual obligations have been met.

PPG 7 TRIAL OPERATION PERIOD

The requirements, if applicable, related to the operation of the plant during the trial operation period shall be stated in the Project Specifications.

The Contractor shall make full allowance for the specified requirements under payment item PPG 8.6 and this allowance shall be paid to the Contractor on successful completion of the Trial Operation Period once all contractual obligations have been met.

PPG 8 MEASUREMENT AND PAYMENT

PPG 8.1 SCHEDULED FIXED CHARGE ITEMS

PPG 8.1.1 Contractual Requirements Unit: Sum

The sum tendered shall cover the Contractor's initial costs of providing the Performance Security, insurance of the Works and plant, third party or public liability insurance in the joint

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

1 PPG - Prelim and General - June25 June 2025

names of the Employer and Contractor, unemployment insurance and any other initial financing obligations of a preliminary and general nature.

If additional services are specified for the Contract, the sum amount tendered for these items under PPG 8.5.1 to 8.5.5 shall be excluded from the value of the Performance Guarantee for the execution of the works up to receipt of a Taking Over Certificate as a dedicated guarantee will be required if/when these additional services are to be performed during the defects notification period.

PPG 8.1.2 Facilities for the Contractor Unit: Sum

The sum tendered shall cover the cost of providing and establishing of all offices, workshops, storage sheds, ablution facilities, tools and equipment, services, access and living accommodation in order to commence with the execution of the Contract.

PPG 8.1.3 Contract Nameboard(s) Unit: Sum

The sum tendered shall cover the cost of manufacturing, supply, delivery and erection of the official contract nameboard(s) in accordance with the drawings and details provided.

PPG 8.1.4 Other fixed-charge Obligations Unit: Sum

The sum tendered shall cover the fixed costs of all other obligations that are required for the proper execution of the Works and that are not specifically covered elsewhere.

PPG 8.1.5 Removal of Site Establishment Unit: Sum

The sum tendered shall cover the cost of the demolition of and the removal from the surface of the Site of all items established in terms of PPG 8.1.2 and shall provide for the making good and the restoring of the Site to the satisfaction of the Engineer.

PPG 8.1.6 Compliance with the Occupational Health and Safety Act, its regulations
And the Employer's Health and Safety Specification Unit: Sum

The sum tendered shall cover the cost of initial compliance with the requirements of the Occupational Health and Safety Act, its regulations and the Employer's Health and Safety Specification bound into the tender document. This fixed charge item shall include, but not be limited to, the provision of the safety file, health and safety training, fences, signs and barricades, baseline medicals for employees employed on the Contract and procurement of necessary Personal Protective Equipment (PPE).

Payment of fixed charge items

Payment of the lump sums tendered under fixed charge items shall be made in three (3) separate installments as follows:

- The first instalment, which is 40% of the lump sum, will be paid when the Contractor has met all his obligations to date under this section, the General Conditions of Contract, as amended, and where the value of the work certified for payment, excluding materials on Site and any payment under preliminary and general items is equal to not less than 5% of the Accepted Contract Amount.
- The second instalment, which is 40% of the lump sum, will be paid when the amount certified for payment, including retention monies but excluding the second instalment referred herein, exceeds 50% of the Accepted Contract Amount.
- The final payment, which is 20% of the lump sum, will be made when the amount certified

for payment, including retention monies but excluding the third instalment referred herein, exceeds 75% of the Accepted Contract Amount.

PPG 8.2 SCHEDULED TIME-RELATED ITEMS

PPG 8.2.1 Contractual Requirements Unit: Sum

The sum tendered shall cover the Contractor's time-related costs of maintaining the Performance Security, insurance of the Works and plant, third party or public liability insurance, unemployment insurance and any other initial financing obligations of a preliminary and general nature.

PPG 8.2.2 Facilities for the Contractor Unit: Sum

The sum tendered shall cover the Contractor's costs for site rentals, repairs to and depreciation of buildings, furniture, tools and equipment, the storage and distribution of fuels and lubricants, services, communications, access and sanitation and the wages of the staff appointed to operate and maintain these facilities.

The provision of adequate security during the installation and commissioning period shall also be included under this payment item.

PPG 8.2.3 Supervision for the duration of installation Unit: Sum

The sum shall cover the costs of on-site supervision and such local administration as the Contractor considers necessary for the proper installation of equipment and completion of the Works and shall cover the cost of the salaries, wages and allowances paid to site agents, technicians, foremen, assistants and other supervisory staff, including transport of accommodation of such staff.

PPG 8.2.4 Company and Head Office Overhead Costs for the duration of the Contract Unit: Sum

The sum tendered shall cover the Contractor's company and head office overhead charges.

PPG 8.2.5 Other time-related charge Obligations Unit: Sum

The sum tendered shall cover the time-related costs of all other obligations that are required for the proper execution of the Works and that are not specifically covered elsewhere.

PPG 8.2.6 Compliance with the Occupational Health and Safety Act, its regulations
And the Employer's Health and Safety Specification Unit: Sum

The sum tendered shall cover the cost of ongoing compliance with the requirements of the Occupational Health and Safety Act, its regulations and the Employer's Health and Safety Specification bound into the tender document. This time-related charge item shall include, but not be limited to, for the following:

- The employment cost of all health and safety personnel including consultants, health and safety officers, inspectors, supervisors and issuers required in terms of the Contractor's Health and Safety Plan,
- Updating the Health and Safety Plan as needed,
- Carrying out of periodic own audits and follow-up audits,
- Compiling ongoing risk assessments and risk assessment reports as required by the Works,
- Convening of regular safety meetings with the Safety Representatives,
- Accompanying and supporting the Employer or his Safety Agent during *ad hoc* audits,

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Compilation of monthly safety reports and statistics for the Employer or his Safety Agent,
- Implementation and maintenance of Training
- Maintenance of personal protective clothing and equipment
- Maintenance of fences, signs and barricades
- Implementation and maintenance of safety administration
- Other Health and Safety Time-related Obligations

PPG 8.3 OTHER GENERAL CHARGES

PPG 8.3.1 Temporary storage of equipment Unit: m³-month

The tendered shall include full compensation for the temporary storage of equipment in terms of clause C3.4.1.11 to be provided by the Contractor, including all double handling, packing material, insurance, maintenance, storage costs, corrosion protection, administrative costs and additional transport.

PPG 8.3.2 Provide 'As Built' drawings Unit: Sum

The sum tendered shall include full compensation for the provision of As-Built drawings drafted by a qualified draughtsperson and in accordance with the requirements of clause C 3.4.1.5.2.

PPG 8.3.3 Provide Operation and Maintenance Manuals Unit: Sum

The sum tendered sum shall include full compensation for the provision of draft manuals, submitting these to the Engineer for approval, modifying as required until the manuals have been approved by Engineer. The tendered sum shall further include for full compensation for providing the necessary amount of copies as specified under clause C3.4.1.5.3.

PPG 8.3.4 Training Unit: Sum

The tendered sum shall include full compensation for the delivery of training to the operating personnel identified by the Employer, including all literature and hand-outs but excluding catering, accommodation and facilities. Also refer to C3.4.1.12 for details.

PPG 8.3.5 Charges and Profit on maintenance spares Unit: %

The unit of measurement shall be the % tendered on the actual amount spent and shall include full compensation for all overhead charges, profit, handling and delivery to Site of maintenance spares as ordered under provisional item PPG 8.4.1.

PPG 8.4 SUMS STATED PROVISIONALLY BY THE ENGINEER

PPG 8.4.1 Maintenance Spares Unit: Prov Sum

The provisional sum shall provide for the acquisition at the sole discretion of the Employer of critical maintenance spares.

PPG 8.4.2 Specialist external inspectorate Unit: Prov Sum

The provisional sum allows for the costs of all external inspectorates appointed by the Employer during the course of the Contract, which will be paid by the Contractor from this provision upon instruction by the Engineer.

PPG 8.4.3 Employer's Health and Safety Officer Unit: Prov Sum

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The provisional sum allows for the costs of the Employer's health and safety officer appointed by the Employer in terms of the Occupational Health and Safety Act and its regulations for the duration of construction.

PPG 8.4.4 Water Quality Sampling and Testing Unit: Prov Sum

The provisional sum shall provide for the sampling and testing of any/all water samples as directed by the Engineer.

PPG 8.4.5 Water Quality Instruments Unit: Prov Sum

The provisional sum shall provide for the acquisition at the sole discretion of the Employer of any/all instruments and equipment required for the on-site laboratory.

PPG 8.5 ADDITIONAL SERVICES

PPG 8.5.1 Site visits and reporting Unit: Visit

The Contractor, or a designated and approved representative, shall visit the Works at least twice per calendar month to execute a conditional assessment of the mechanical and electrical equipment installed under the Contract, assess the performance of the plant since the last reporting period, take the necessary water quality samples, discuss any/all operational problems with the on-site operators, engage in ongoing training where required, record flow data and compile the necessary report for the Engineer's approval. The Contractor's tendered rate shall include for all direct and indirect expenses associated with these site visits and shall include, but not be limited to, travel costs, travelling time costs, time cost for work on site, stationary, report writing etc.

PPG 8.5.2 Water Quality Sampling Unit: Sum (per set)

The Contractor shall appoint an accredited laboratory to sample the Works and analyse the samples for the water quality parameters listed under sub-clause PPG 6.2 in accordance with industry-norm methods and procedures and shall allow for all direct and indirect costs associated herewith. Sampling and analyses shall be executed twice per calendar month and results shall be submitted to the Engineer and the Employer as soon as it becomes available.

PPG 8.5.3 Maintenance and Serving of Mechanical and Electrical Equipment Unit: Sum

The Contractor shall maintain all mechanical and electrical equipment installed under the Contract for the full duration of the defects notification (maintenance) period and shall provide all labour, travel, handling, consumables, oil, lubricants, tools, equipment etc associated herewith.

PPG 8.5.4 Supply of chemicals Unit: Sum

The Contractor shall supply and uphold all chemicals required for the operation of the Works for the duration of the defects notification period and shall provide all labour, travel, consumables, tools etc associated herewith.

Important note: This provision shall remain in force until the amount of chemicals allowed for in tender has been reached.

PPG 8.5.5 Performance Guarantee Unit: Sum

The rate tendered shall cover the initial costs as well as maintaining during the defects notification period of a suitable and approved performance guarantee for the provision of the additional services described above, to the value of the tendered sum for items PPG 8.5.1 to

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PPG 8.5.4. It is suggested that 3 bonds be issued and that a bond will be returned to the Contractor every six months once all the contractual requirements have been met.

PPG 8.6 **TRIAL OPERATION PERIOD** Unit: Sum

The Contractor shall make allowance under this payment item for all direct and indirect costs related to complying with the specified requirements of the Trial Operation Period as described in the Project Specifications.

RUSTENBURG WATER SERVICES TRUST

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**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTB DISSOLVED AIR FLOTATION (DAF) EQUIPMENT

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PTB DISSOLVED AIR FLOTATION (DAF) EQUIPMENT

PTB 1 SATURATORS

These are pressure vessels filled with plastic media and positioned on the flotation tanks as shown on the drawings. The saturators supply a saturated air-water solution to the reactor zone where it is mixed with the flocculated water.

On the side of the cylinders at the top a 450 mm dia bolted manhole has to be provided to permit access for inspection and maintenance.

The operating pressure inside the saturator shall be 500 kPa.

The recycle water enters any saturator at the centre of the cylinder at the top through the inlet pipe and discharges vertically downwards against a steel tray with holes which spreads the water to ensure an even distribution over the full area of the cylinder.

The saturator shall be filled with 40 mm Plastic Pall Rings. A grid prevents the media from entering the outlet pipe. Pall Rings are to be equal or similar to those supplied by Messrs BB Enterprises, Tel (012) 6535051.

The lower part of the saturator serves as a reservoir of air-saturated water and the fluctuation in water level must actuate an isolating valve on the air supply line.

The lower portion of the saturator vessel must be provided with a magnetic level indicator and the isolating valve on the air feed pipe shall be controlled by a signal picked up from the water level in the level indicator. The position of the sensors picking up the signal must be adjustable.

Each magnetic level indicator shall be supplied with two switches and adjustable clips. The cabling between the level indicator and the solenoid valve shall form part of this Contract.

The saturator is to be provided with a flanged outlet at the base, steel supporting legs and footplates which can be bolted to the existing floor.

A glycerine filled pressure gauge with a 100 mm dia face, isolating valve and pressure release valve is to be included to comply with safety regulations.

The Contractor shall be responsible for the fabrication of the saturators and in particular for complying with all Government regulations regarding the manufacture and testing of a pressure vessel of this type.

It is essential that the accuracy of the dimensions as shown on the Works Drawings be adhered to as this affects pipe dimensions to and from the saturator.

Working drawings must be approved by the Engineer before proceeding with the manufacture.

The applicable test certificates must be submitted in compliance with the Government Regulations regarding the manufacture and testing of a pressure vessel of this type prior to delivering to site.

PTB 2 NOZZLES

The air saturated water from each saturator is fed into three parallel pipes fitted with nozzles spaced according to the description in the pipe special list.

PTB 3 SATURATOR AIR FEED PIPEWORK

The Contractor shall supply and fix a suitable Galvanised Mild Steel (GMS) pipe, from the air compressor to each saturator. A reflux valve, must be provided on each pipe before entering the saturator.

PTB 4 AIR COMPRESSOR FOR DAF

The compressors and the air receiver will be positioned on the walkway in the flotation tanks as shown on the drawings, and the Contractor shall allow in the rate of the compressors for a complete installation to comply to the applicable safety requirements and all air feed pipework and fittings to the two saturators fixed and supported to the Engineers approval.

PTB 5 MEASUREMENT AND PAYMENT

- (a) Saturators will be measured complete per unit including media, level indicators, gauges, pressure tests, etc as specified.
- (b) Air compressors will be measured complete per unit including air pipework to the saturators as specified.
- (c) Pipework will be measured as a sum for all inlet and outlet pipework (including nozzles) complete including installing, building into walls, painting and jointing materials.

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PTT : RAPID GRAVITY FILTERS

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PTT RAPID GRAVITY FILTERS

PTT 1 SCOPE

This section of the Specification deals with the supply, delivery, installation, commissioning and a 12 month maintenance period of rapid gravity filter units, consisting of filter floors and filter media inside a filter box as constructed by others.

PTT 2 INTERPRETATIONS

PTT 2.1 Filter Box

The concrete structure housing the filter floors, filter media and wash-out channel as shown on the drawings. Filter boxes will be constructed by others, and each will comprise of two equal bays, allowing each bay to be backwashed individually.

PTT 2.2 Inlet Box

The concrete structure in the settled water channel which allows the water to enter the filter over a weir. Flow into a particular filter will depend on the number of filters in operation at any time.

PTT 2.3 Filter Floor

The filter floor with its under drains, supports the filter media, collects the filtered water and distributes the wash water and air scour. The floor is formed by lateral pipes into which filter nozzles are screwed. The floor pipework is embedded in a concrete layer approximately 200 mm thick with the nozzles projecting above the concrete surface.

PTT 2.4 Filter Nozzle

A slotted head secured to a tube designed to screw into a bush or boss cemented to the crown of a lateral pipe. The nozzle collects the filtered water and also distributes the wash water and air flow in an upward mode through the filter media.

PTT 2.5 Filter Media

The filter media consists of quartzitic grit and sand placed in layers with a particular grading.

PTT 2.6 Outlet Box

The concrete structure in the filter gallery into which the water passes after filtration.

PTT 3 MATERIALS

PTT 3.1 Selection against Corrosion

In a water treatment plant, the extremely corrosive environment and substances in contact with the materials and equipment require that special attention be given to the selection of materials and equipment capable of withstanding corrosion.

Any material or equipment showing signs of corrosion during the Maintenance Period shall be rejected and will be replaced by the Contractor at his own expense with materials or equipment resistant to corrosion as test proven.

PTT 3.2 Guarantee

All equipment shall be guaranteed against faulty design, materials and workmanship for a period of 12 months from the date of commissioning. During this period the contractor shall rectify, at his own cost, any defects which can be attributed to faulty design, materials and workmanship. Normal wear and tear shall be excluded.

PTT 3.3 Information and Technical Data at Tendering

Comprehensive information and technical data on all materials and equipment offered, shall be supplied at tender stage. Manufacturer's pamphlets and catalogues shall be edited and clearly marked so as to describe the particular equipment offered.

PTT 3.4 Filter Boxes

Concrete structures by others.

PTT 3.5 Filter Floor

All pipework in the floor shall be suitably rated uPVC piping. Support framework and levelling devices protected, in accordance with relevant material and corrosion protection, specified elsewhere.

PTT 3.6 Filter Media

The filter media, consisting of clear, hard, equal grain size, quartzitic sand, conforming to the grading analysis is specified under PTT 6.3.

PTT 3.7 Inlet and Outlet Box Weirs

The weir plates shall be fabricated of grade 304 L stainless steel with a No. 1 finish. Tiled or other approved materials on areas where indicated on the drawings.

PTT 4 PLANT REQUIRED AND DELIVERIES

The Contractor has to supply and maintain suitable tools, plant and equipment so as to be able to perform as per specification.

The Contractor shall be responsible for the off-loading and protection of all material and equipment on site as well as the stacking of such material in a depot indicated by the Engineer.

No deliveries will take place on Saturdays, Sundays or statutory non-working days unless special arrangements have been made with and agreed to by the Engineer.

The Contractor shall be solely responsible for obtaining transport permits and clearance from road or rail authorities for the transporting and delivery of materials and equipment as well as the compliance with the requirements of such bodies.

PTT 5 CONSTRUCTION

A rapid gravity filter unit shall be a functional entity capable of filtering settled raw water and of being air-scoured and backwashed to clean the filter bed when required. Thus, to achieve this requirement, this unit shall comprise of all necessary controls, flow meters, valves, pipework inside and outside filter bays, air scour and backwash water system and other ancillary equipment. The civil structures, filter boxes, and filter gallery for housing filter units are not included.

Contractor

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PTT 5.1 Filter Boxes

The basic structural concrete, forming the filter box and gallery, will be done by others, as shown on the drawings. The filter floor will be installed in the filter box and all ancillary equipment to form or hold the floor in place shall be part of this installation.

PTT 5.2 Filter Floor

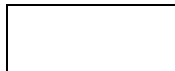
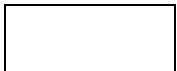
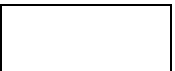
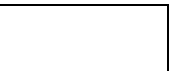
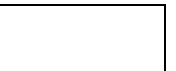
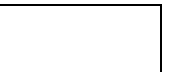
The filter floor shall consist of a lateral pipework system with filter nozzles, embedded in a concrete layer.

The filter floor shall include for the under drain system complete with all necessary transverse and lateral pipes that may be required. The proposed air scour and backwash water rates shall be stipulated in the tender as well as the maximum expansion of the filter bed during backwash

- a) A depth of 200 mm will be allowed for the filter floors. Should this depth not be sufficient for the Tenderer's proposed filter floors, this must be clearly stated in his Tender.
- b) It must be able to filter water at rates of 3 m³/m²/h to 9 m³/m²/h.
- c) Filter nozzles must be replaceable and shall not be spaced more than 200 mm apart in any direction. The installed laterals must be evenly spaced in order to achieve a symmetrical nozzle layout over the complete floor area. Nozzles to be equidistant from inner vertical walls of filter box.
- d) Provision must be made for separate air scour and backwash water systems.
- e) It is of the utmost importance that the air and backwash water be evenly distributed over the entire filter floor during the backwash process. The tenderer to state air scour and backwash water rates.
- f) After installation of the filter floor, and a 100 mm layer of sand or grit is placed, it must be possible to walk on the floor without causing any damage.
- g) The Tenderer must provide, with his tender, comprehensive details and drawings of the complete floor system offered, together with the necessary literature on the:
 - Nozzle. Dimensions of the complete nozzle and all orifices. A pressure loss curve for the passage of air and backwash water within the ranges specified and a sample of the proposed nozzle.
 - Lateral pipework. Dimensions and details of the boxes, pipework and information regarding the levelling and fixing/anchoring of said pipework to the filter box floor and over the drainage duct.
 - Reinforcing details, to ensure a homogeneous floor capable of with- standing the uplift over the drainage duct. Anchoring details of infill concrete for filter floor onto structural filter box floor.

Inspections will be carried out at critical stages of construction, such as:

- Before the infill concrete is placed. The levelness of the bushes on the laterals will be checked (preferably with a water layer on the floor).
- When reinforcing is placed and the anchoring secured.

					
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- After completing joint sealing.
- When nozzles have been installed - to evaluate the air bubble pattern over the floor. Before media is placed, 100 mm water cover to be let in above the filter nozzles, and the air scour system activated.

PTT 5.3 Filter Media

The thickness of the layer as placed, will be measured after placing the layer and covering it with water to obtain the maximum in situ density.

The grading of filter media and the depth of the filter bed shall be such that 240 m³ of filtered water per m² of filter bed per filter run can be achieved. The turbidity of the filtered water shall be less than 1 NTU and the turbidity of the settled water being filtered up to 7,5 NTU. The design of the filter bed shall also take into account that the headloss over the filter can be up to 2 metres waterhead before backwash.

The Tenderer must provide, with his tender a complete grading analysis of the media offered for each of the layers, as well as particulars of where the different media will be obtained.

Should it be required, 1 kg samples of each of the different types of media offered, must be submitted for approval within 14 days after such request.

The approved method for placing the filter media to the correct depth, is to mark the filter wall at the specified depth and place the prescribed media up to this mark. Water is then introduced up to this mark and any high or low spots are made good.

The top filter sand layer must be placed to a level approximately 10 mm higher than specified; then covered with water. Ten backwash cycles should be carried out, i.e. air scouring, followed by backwashing, in order to bring the finer media particles to the surface. The top layer, with these fines, ±10 mm thick, must then be removed, leaving the remaining media with the desired grading and depth.

Media shall be dispatched to the site securely contained in bags. After placing the media, excess material shall remain in bags.

PTT 5.4 Air Blower Units

Two air blowers, preferably of the rolling drum type (Roots type), shall be provided for air scouring of the filter media.

The blowers will be used alternately. Piping shall be arranged so that this be possible by the switching of the necessary valves.

The capacity of each blower shall be adequate for the air demand for one (1) filter or one filter bay at the specified air scour rate (PTT 5.2). This capacity shall be achievable at the head created by piping, fittings, filter floor and filter media when the latter is covered with water up to the level of the wash-out weir.

The blower and motor shall be properly aligned and mounted on a common baseplate of rigid design. The design shall allow for easy removal and replacement of either component for maintenance and repair purposes.

The discharge on each blower shall be provided with a suitable cut-off valve to enable the removal of either blower for maintenance purposes without hampering the operation of the other blower. One-way valves shall be provided to prevent blow-back through the standby blower during normal operation with the valves open.

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A relief valve, capable of being easily and accurately set and remaining set, shall be installed to prevent damage to either or both blowers should they inadvertently be started against closed valves.

Each air blower shall be equipped with a suitable silencer and suction dust filter.

Adequate non-return valves and/or traps shall be provided to prevent blow-back of water into the blower during working operations.

Pressure shall be displayed in kPa on a suitably rated 100 mm dial type pressure gauge on the discharge side of an air blower. A stop-cock shall be provided underneath the pressure gauge to enable removal thereof without disrupting the operation of the blower. The pressure gauge shall be wall-mounted.

The blowers will be controlled from the filter control panels under normal working conditions.

Each blower shall be provided with a wall-mounted, front access motor control board complete with suitable electrical design (suitable effective single phase protection shall be included). Starting shall be direct on line.

The motor control board shall be supplied by others and equipped with the following functions for display/operation at the board:

- A single ammeter with selector switch for the three phase currents.
- Running hour logger.
- Manual/remote selector switch. Remote refers to control from the filter control panels.
- Stop, start/running and overload trip/reset illuminated pushbuttons.
- Connection to filter control panels.

PTT 5.5 Washwater Pumps

Washwater pumps are specified in section PPT.

PTT 5.6 Inlet and Outlet Boxes

Constructed by others.

PTT 6 TOLERANCES

PTT 6.1 Filter Box

The concrete finishes and tolerances as described on the filter layout drawing or defined by the SABS 1200 G code for structural concrete.

PTT 6.2 Filter Floor

PTT 6.2.1 The top of the nozzles shall all be at the same level to within $\pm 1,5$ mm, i.e. the difference in level between the highest and the lowest nozzle shall not be more than 3 mm.

PTT 6.3 Filter Media

The filter media will have a total depth as detailed on the drawings. The specification of the proposed media, to suit the filter floor system, must be submitted in the Technical Schedule of the Tender.

For each layer the percentage larger than the largest size specified shall not be more than 2% and the percentage smaller than the smallest size specified shall not be more than 5%.

PTT 7 INSPECTIONS AND TESTS

Washwater and air will be pumped to individual filters and special attention will be given to air distribution by individual nozzles, making sure that the entire filter floor is level. Refer also to PTT 5.2.

PTT 8 COMMISSIONING AND ACCEPTANCE

The Contractor shall commission all equipment and put in readiness for use.

The handover/acceptance of equipment shall be preceded by a forty-eight (48) hour trial run by the Contractor to enable him to prove to the Engineer that all equipment and the plant as a whole perform to requirements.

Thereafter, the equipment shall be run by the Contractor as directed by the Engineer for an extended period of approximately five (5) days. Thorough inspection, testing, etc. of all equipment will then take place and said equipment will be evaluated by the Engineer for acceptance or rejection. The Contractor shall schedule this period so as to allow himself enough time to remedy, replace, etc. unsatisfactory work, equipment, etc. and still meet the final completion date.

Costs incurred for all unsuccessful acceptance tests will be borne by the Contractor.

PTT 9 MEASUREMENT AND PAYMENT

Supply and delivery of equipment and materials shall be priced separately from installation and commissioning in the Schedule of Quantities.

All rates, lump sums and prices under supply and delivery of equipment and materials to include for supply/manufacture, factory-applied corrosion protection, delivery to site, off-loading and storing.

All rates, lump sums and prices under installation and commissioning of equipment and materials to include for all labour, materials, plant, supervision, handling, installation, on-site corrosion protection application, testing, commissioning and maintenance for a 12 month period.

All the above to be in accordance with specification.

PTT 9.1 Rapid Gravity Filter Units

PTT 9.1.1 Filter Floors

Shall be priced as a lump sum.

The rate shall include for the complete filter floor and underdrain system. The pipework outside the filter bay will be measured separately.

PTT 9.1.2 *Filter Media*

Shall be measured per m³ placed.

The rate for filter media shall include for covering with water and removal of the 10 mm fines in accordance with PTT 5.2.

PTT 9.1.3 *Air Blower Units*

Shall be priced per unit complete.

The rate for air blower units shall include for:

- (i) Air blowers complete with motors, couplings, baseplates, air filters, silencers, water drains, etc.
- (ii) Pipework from blowers is priced separately.

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTTG : GRANULAR ACTIVATED CARBON FILTERS

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PTTG GRANULAR ACTIVATED CARBON FILTERS

PTTG 1 SCOPE

This section of the Specification deals with the supply, delivery, installation, commissioning and a 12 month maintenance period of granular activated carbon filter units, consisting of filter floors and filter media inside a filter box as constructed by others.

PTTG 2 INTERPRETATIONS

PTTG 2.1 Filter Box

The concrete structure housing the filter floors and filter media. Wash-out channel is suspended above the filter box as shown on the drawings. Filter boxes will be constructed by others, and will comprise a single bay.

PTTG 2.2 Inlet Box

The concrete structure in the feed channel which allows the water to enter the filter over a weir. Flow into a particular filter will depend on the number of filters in operation at any time.

PTTG 2.3 Filter Floor

The filter floor with its under drains, supports the filter media, collects the filtered water and distributes the wash water and air scour. The floor is formed by lateral pipes into which filter nozzles are screwed. The floor pipework is embedded in a concrete layer approximately 200 mm thick with the nozzles projecting above the concrete surface.

PTTG 2.4 Filter Nozzle

A slotted head secured to a tube designed to screw into a bush or boss cemented to the crown of a lateral pipe. The nozzle collects the filtered water and also distributes the wash water and air flow in an upward mode through the filter media.

PTTG 2.5 Filter Media Grading

The filter media consists of a single GAC grading.

PTTG 2.6 Outlet Box

The concrete structure in the filter gallery into which the water passes after filtration.

PTTG 3 MATERIALS

PTTG 3.1 Selection against Corrosion

In a water treatment plant, the extremely corrosive environment and substances in contact with the materials and equipment require that special attention be given to the selection of materials and equipment capable of withstanding corrosion.

Any material or equipment showing signs of corrosion during the Maintenance Period shall be rejected and will be replaced by the Contractor at his own expense with materials or equipment resistant to corrosion as test proven.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2
June 2025

PTTG 3.2 Guarantee

All equipment shall be guaranteed against faulty design, materials and workmanship for a period of 12 months from the date of commissioning. During this period the contractor shall rectify, at his own cost, any defects which can be attributed to faulty design, materials and workmanship. Normal wear and tear shall be excluded.

PTTG 3.3 Information and Technical Data at Tendering

Comprehensive information and technical data on all materials and equipment offered, shall be supplied at tender stage. Manufacturer's pamphlets and catalogues shall be edited and clearly marked so as to describe the particular equipment offered.

PTTG 3.4 Filter Boxes

Concrete structures by others.

PTTG 3.5 Filter Floor

All pipework in the floor shall be suitably rated uPVC piping. Support framework and levelling devices protected, in accordance with relevant material and corrosion protection, specified elsewhere.

PTTG 3.6 Filter Media

The filter media, consisting of Granular Activated Carbon conforming to the grading specified in the Project Specification and the quality specified in the Particular Specification - PTG.

PTTG 3.7 Inlet and Outlet Box Weirs

The weir plates shall be fabricated of grade 316 L stainless steel with a No. 1 finish. Tiled or other approved materials on areas where indicated on the drawings.

PTTG 4 PLANT REQUIRED AND DELIVERIES

The Contractor has to supply and maintain suitable tools, plant and equipment so as to be able to perform as per specification.

The Contractor shall be responsible for the off-loading and protection of all material and equipment on site as well as the stacking of such material in a depot indicated by the Engineer.

The Contractor shall be solely responsible for obtaining transport permits and clearance from road or rail authorities for the transporting and delivery of materials and equipment as well as the compliance with the requirements of such bodies.

PTTG 5 CONSTRUCTION

A granular activated carbon filter unit shall be a functional process capable of filtering water and being air-scoured and backwashed to clean the filter bed when required. Thus, to achieve this requirement, this unit shall comprise of all necessary controls, flow meters, valves, pipework inside and outside filter bays, air scour and backwash water system and other ancillary equipment. The civil structures, filter boxes, and filter gallery for housing filter units are not included.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2
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PTTG 5.1 Filter Boxes

The basic structural concrete, forming the filter box and gallery, will be done by others, as shown on the drawings. The filter floor will be installed in the filter box and all ancillary equipment to form or hold the floor in place shall be part of this installation.

PTTG 5.2 Filter Floor

The filter floor shall consist of a lateral pipework system with filter nozzles, embedded in a concrete layer.

The filter floor shall include the under drain system complete with all necessary transverse and lateral pipes that may be required. The proposed air scour and backwash water rates shall be stipulated in the tender as well as the maximum expansion of the filter bed during backwash

- a) A depth of 200 mm will be allowed for the filter floors. Should this depth not be sufficient for the Tenderer's proposed filter floors, this must be clearly stated in his Tender.
- b) It must be able to filter water at rates of 3 m³/m²/h to 9 m³/m²/h.
- c) Filter nozzles must be replaceable and shall not be spaced more than 200 mm apart in any direction. The installed laterals must be evenly spaced in order to achieve a symmetrical nozzle layout over the complete floor area. Nozzles to be equidistant from inner vertical walls of filter box.
- d) Provision must be made for separate air scour and backwash water systems.
- e) It is of the utmost importance that the air and backwash water be evenly distributed over the entire filter floor during the backwash process. The tenderer to state air scour and backwash water rates.
- f) After installation of the filter floor, and a 100 mm layer of GAC, it must be possible to walk on the floor without causing any damage.
- g) The Tenderer must provide, with his tender, comprehensive details and drawings of the complete floor system offered, together with the necessary literature on the:
 - Nozzle. Dimensions of the complete nozzle and all orifices. A pressure loss curve for the passage of air and backwash water within the ranges specified and a sample of the proposed nozzle.
 - Lateral pipework. Dimensions and details of the boxes, pipework and information regarding the levelling and fixing/anchoring of said pipework to the filter box floor and over the drainage duct.
 - Reinforcing details, to ensure a homogeneous floor capable of with- standing the uplift over the drainage duct. Anchoring details of infill concrete for filter floor onto structural filter box floor.
 - Backwash and scour equipment and flow rate details.

Inspections will be carried out at critical stages of construction, such as:

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- Before the infill concrete is placed. The levelness of the bushes on the laterals will be checked (preferably with a water layer on the floor).
- When reinforcing is placed and the anchoring secured.
- After completing joint sealing.
- When nozzles have been installed - to evaluate the air bubble pattern over the floor. Before media is placed, 100 mm water cover to be let in above the filter nozzles, and the air scour system activated.

PTTG 5.3 Filter Media Placement

The thickness of the layer as placed, will be measured after placing the layer and covering it with water to obtain the maximum in situ density.

The design of the filter bed shall also take into account that the headloss over the filter can be up to 2 metres waterhead before backwash.

The Tenderer must provide, with his tender a complete grading analysis of the media offered for each of the layers, as well as particulars of where the different media will be obtained as detailed in PTG.

The approved method for placing the filter media to the correct depth, is to mark the filter wall at the specified depth and place the prescribed media up to this mark. Water is then introduced up to this mark and any high or low spots are made good.

The top GAC layer must be placed to a level approximately 10 mm higher than specified; then covered with water. Ten backwash cycles should be carried out, i.e. air scouring, followed by backwashing, in order to bring the finer media particles to the surface. The top layer, with these fines, ±10 mm thick, must then be removed, leaving the remaining media with the desired grading and depth.

Media shall be dispatched to the site securely contained in sealed bags. After placing the media, excess material shall remain in bags.

PTTG 5.4 Air Blower Units

Two air blowers, preferably of the rolling drum type (Roots type), shall be provided for air scouring of the filter media.

The blowers will be used alternately. Piping shall be arranged so that this be possible by the switching of the necessary valves.

The capacity of each blower shall be adequate for the air demand for one (1) filter at the specified air scour rate. This capacity shall be achievable at the head created by piping, fittings, filter floor and filter media when the latter is covered with water up to the level of the wash-out weir.

The blower and motor shall be properly aligned and mounted on a common baseplate of rigid design. The design shall allow for easy removal and replacement of either component for maintenance and repair purposes.

The discharge on each blower shall be provided with a suitable cut-off valve to enable the removal of either blower for maintenance purposes without hampering the operation of the

other blower. One way valves shall be provided to prevent blow-back through the standby blower during normal operation with the valves open.

A relief valve, capable of being easily and accurately set and remaining set, shall be installed to prevent damage to either or both blowers should they inadvertently be started against closed valves.

Each air blower shall be equipped with a suitable silencer and suction dust filter.

Adequate non-return valves and/or traps shall be provided to prevent blow-back of water into the blower during working operations.

Pressure shall be displayed in kPa on a suitably rated 100 mm dial type pressure gauge on the discharge side of an air blower. A stop-cock shall be provided underneath the pressure gauge to enable removal thereof without disrupting the operation of the blower. The pressure gauge shall be wall-mounted.

The blowers will be controlled from the filter control panels or PLC system as specified in the Project Specification.

Each blower shall be provided with a wall-mounted, front access motor control board complete with suitable electrical design (suitable effective single phase protection shall be included). Starting shall be direct on line.

The motor control board shall be supplied by others and equipped with the following functions for display/operation at the board:

- A single ammeter with selector switch for the three phase currents.
- Running hour logger.
- Manual/remote selector switch. Remote refers to control from the filter control panels.
- Stop, start/running and overload trip/reset illuminated pushbuttons.
- Connection to filter control panels.

PTTG 5.5 Pipework in Filter Gallery

The requirements for this pipework are as follows:

- Pipework shall be of steel. The steel pipes, specials and fittings shall be manufactured in accordance with Specification DWS 1130.
- Pipework shall be epoxy lined and coated in accordance with the Specification DWS 1131.
- Pipe diameters not specified shall be determined by the Tenderer to suit equipment offered and to conform to required flow rates.
- Pipes shall be adequately supported by brackets or other suitable method. Additional support shall be provided if required by the Engineer at the contractor's expense.
- Where pipes pass through reinforced concrete walls suitable puddle flanges shall be provided.

Contractor

Witness 1

Witness 2

Employer

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- After installation all pipework and valves shall be painted with two layers of an enamel paint to comply to a colour coding system as determined by the Engineer. Paint to be applied only after suitable surface preparation as required by the paint manufacturer.

PTTG 5.6 Flowmeter

A flowmeter shall be supplied and installed in the backwash water feed to indicate the backwash water flow rate. The requirements for the flowmeter and indicator are as follows:

- The accuracy displayed at the indicator shall be +5% or better of the actual flow from 10% to 100% of design flow.
- The meter shall be suitable for the flows, pressures and aggressiveness of the water foreseen at the measuring point.
- The meter shall be positioned to facilitate easy removal and reinstallation for maintenance purposes.
- The flowrate in P/s shall be displayed on a wall mounted indicator with a 200 mm minimum diameter scale. Full scale reading shall be at least 25% higher than the backwash design flow rate.
- The indicator shall be positioned in the filter gallery to facilitate easy reading at the filter control panels.

PTTG 5.7 Valves

The backwash water and air scour control valves shall be operated easily under all backwash pump and air blower delivery heads respectively.

The tenderer to submit comprehensive details of all valves offered.

Valves shall be either hand operated or power operated.

All power operated valves shall be provided with a handwheel or other controls for manual operation.

All valves supplied shall be in accordance with the Standard Specification for the Supply of Valves, DWS 2510.

Technical Schedules included in this document shall be completed at the time of tendering.

PTTG 5.8 Filter Control Panels

The controls for a complete backwash cycle (including air scour) shall be grouped together in one control panel for each filter.

Stop/start buttons for the washwater pump and the air blower shall be located in each panel. Suitable safety devices shall be installed to prevent the air blower being started while the backwash valve is open.

All controls shall be labelled so as to clearly indicate their function. For the backwash pumps and air blowers the controls shall also indicate when the pump or blower is running.

The control panel shall be a free standing, spray-painted metal unit of pleasing appearance. Paint to be applied only after suitable surface preparation in accordance with the paint manufacturer's specifications.

PTTG 5.9 Washwater Pumps

Two washwater pumps, preferably centrifugal pumps operating at ± 1500 rpm, shall be provided for backwashing of the filter media. The pumps will be used alternately.

The backwash rate shall be adequate for the required demand for one filter bay at the Tenderer's proposed backwash rate. The rate shall be checked after installation by measuring the washwater upflow rate above the filter media. The pump duty must be adequate for the head created by the piping, fittings, filter floor and filter media when the latter is covered with water up to the level of the wash-out weir.

The pump and motor shall be properly aligned and mounted on a common baseplate of rigid design. The design shall allow for ease of removal and replacement of either component for maintenance and repair purposes.

The discharge on each pump shall be provided with a suitable cut-off valve to enable the removal of either pump for maintenance purposes without hampering the operation of the other pump. One way valves shall be provided to prevent back-flow through the standby pumps during normal operation with the valves open.

Pressure shall be displayed in kPa on a suitably rated 100 mm dial type pressure gauge on the discharge end of each. A stop-cock shall be provided underneath the pressure gauge to enable removal thereof without disrupting the operation of the blower. The pressure gauge shall be wall-mounted.

The washwater pump will be controlled from the filter control panels under normal working conditions.

Each pump shall be provided with a motor control board complete with suitable electrical design (suitable effective single phase protection shall be included). Starting shall be direct on line.

A motor control board shall be supplied by others and be equipped with the following functions for display/operation:

- A single ammeter with selector switch for the three phase currents.
- Running hour logger.
- Manual/remote selector switch. Remote refers to control from the filter control panels.
- Stop, start/running and overload trip/reset illuminated pushbuttons.
- The contractor supplying the filter floor equipment will connect the filter control panels to the motor control board.

PTTG 5.10 Inlet and Outlet Boxes

Constructed by others.

PTTG 5.11 Media Removal and Replacement System

In order to facilitate the removal and replacement of media from the GAC filters it is a requirement to install a media removal and replacement system. The media removal and replacement system shall be permanently installed and be integrated with the media dewatering, regeneration and storage systems.

PTTG 5.12 Media Regeneration System

Once the GAC is spent and has reached its adsorptive capacity, it will require regeneration. The GAC can either be regenerated on site with a small regeneration unit operated by plant personnel, or the GAC can be transported to a regeneration facility where it is regenerated by an appointed contractor.

In either case the regeneration system will be required to increase the adsorptive capacity to a pre-specified level. The adsorptive capacity can be measured in various ways, the most popular being Iodine number, Methylene Blue number and Geosmin and 2-MIB adsorption capacity as detailed in PTG.

PTTG 5.13 Media Trap

The GAC media trap will be placed at exit of the backwash channel and the sieve size will be the smallest sieve size specified by media to be placed in the filter. For example if the media size specified is 8X30, the sieve size required will be the number “8” sieve.

The sieve shall be manufactured of 316 stainless steel and able to withstand the pressure of the water exiting the backwash channel. The sieve will also be easy to remove for cleaning and maintenance.

PTTG 6 TOLERANCES

PTTG 6.1 Filter Box

The concrete finishes and tolerances as described on the filter layout drawing, or defined by the SABS 1200 G code for structural concrete.

PTTG 6.2 Filter Floor

PTTG 6.2.1 The top of the nozzles shall all be at the same level to within $\pm 1,5$ mm, i.e. the difference in level between the highest and the lowest nozzle shall not be more than 3 mm.

PTTG 6.3 Filter Media

The filter media will have a total depth as detailed on the drawings. The specification of the proposed media, to suit the filter floor system, must be submitted in the Technical Schedule of the Tender.

For each layer the percentage larger than the largest size specified shall not be more than 5% and the percentage smaller than the smallest size specified shall not be more than 5%.

PTTG 7 CONTROL AND INSTRUMENTATION

Each GAC filter unit shall be supplied with the following instrumentation:

- Level transmitter in filter box above filter media to control filtration rate.
- In line turbidity meter.

- Limit switches on all actuated valves.

All valves on the GAC filter shall be actuated by electric actuator to enable automatic backwashing and filtration control. A dedicated PLC shall be used for this purpose and shall be compatible with the existing PLC network.

The contractor shall provide with his tender the proposed filter control and backwash sequence.

PTTG 8 INSPECTIONS AND TESTS

Washwater and air will be pumped to individual filters and special attention will be given to air distribution by individual nozzles, making sure that the entire filter floor is level. Refer also to PTTG 5.2.

PTTG 9 COMMISSIONING AND ACCEPTANCE

The Contractor shall commission all equipment and put in readiness for use.

The handover/acceptance of equipment shall be preceded by a forty-eight (48) hour trial run by the Contractor to enable him to prove to the Engineer that all equipment and the plant as a whole perform to requirements.

Thereafter, the equipment shall be run by the Contractor as directed by the Engineer for an extended period of approximately five (5) days. Thorough inspection, testing, etc. of all equipment will then take place and said equipment will be evaluated by the Engineer for acceptance or rejection. The Contractor shall schedule this period so as to allow himself enough time to remedy, replace, etc. unsatisfactory work, equipment, etc. and still meet the final completion date.

Costs incurred for all unsuccessful acceptance tests will be borne by the Contractor.

PTTG 10 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PTTG 10.1 Design, Drawings and General

Design, drawings and general supply and delivery of equipment and materials shall be priced separately from installation and commissioning in the Schedule of Quantities.

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

PTTG 10.1.1	Provide design drawings and design information as specified.	Sum
--------------------	--------------------------------------------------------------	-----

PTTG 10.1.2	Provide operating and maintenance manuals and "as built" drawings as specified.	Sum
--------------------	---------------------------------------------------------------------------------	-----

PTTG 10.2 Supply and Delivery to Site

All rates, lump sums and prices under supply and delivery of equipment and materials to include for supply/manufacture, factory-applied corrosion protection, delivery to site, off-loading and storing.

<i>Pay Item</i>	<i>Unit</i>
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<div></div> <div>Contractor</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>	<div></div> <div>Employer</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>
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PTTG 10.2.1 As detailed below for each component of filter system Sum

PTTG 10.3 Installation Work

All rates, lump sums and prices under installation of equipment and materials to include for all labour, materials, plant, supervision, handling, installation and on-site corrosion protection application.

Pay Item **Unit**

PTTG 10.3.1 As detailed below for each component of filter system Sum

PTTG 10.4 Commissioning

All testing and commissioning requirements and maintenance requirements during defects notification period.

Pay Item **Unit**

PTTG 10.4.1 As detailed below for each component of filter system Sum

PTTG 10.5 Provision of additional spare equipment

Pay Item **Unit**

PTTG 10.5.1 As detailed below for each component of filter system Sum

PTTG 10.6 Granular Activated Filter Requirements

PTTG 10.6.1 Filter Floors

Shall be priced as a lump sum per filter floor.

The rate shall include for the complete filter floor and underdrain system. The pipework outside the filter bay will be measured separately.

PTTG 10.6.2 Filter Media

Shall be measured per m³ placed.

The rate for filter media shall include for covering with water and removal of the top 10 mm fines as specified in PTTG 5.3.

PTTG 10.6.3 Air Blower Units

Shall be priced per unit complete.
The rate for air blower units shall include for:

- (i) Air blowers complete with motors, couplings, baseplates, air filters, silencers, water drains, etc.
- (ii) Pipework from blowers is priced separately.

PTTG 10.6.4 Media Removal and Replacement System

Shall be priced as a lump sum.

The rate shall include for the complete media removal and replacement system inclusive of all pipework, pipe fittings and pumps that may be required. The crawl beams installed above the filters are measured as separate items.

PTTG 10.6.5 *Media Regeneration System*

A localised regeneration system shall be priced as a lump sum.

The rate shall include:

- (i) An electric resistance furnace including drying screen, feeders, hoppers, electrical panels, fans, heaters.
- (ii) A suitably sized bag filter system to capture any ash that may be discharged from the furnace with all the necessary ancillary systems.
- (iii) A quenching tank and GAC slurry pump for replacement of GAC in filter bays.

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTG : GAC MEDIA

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PTG GAC MEDIA

PTG 1 GENERAL

This specification describes the quality and properties of the granular activated carbon required for the installation in a fixed bed GAC filtration unit.

PTG 2 QUALITY STANDARDS

The GAC shall comply with the requirements of ANSI/AWWA 604-05 Granular Activated Carbon Standard. The variations to the AWWA standard are described below. It is an express requirement that the GAC must adhere to the ISO 9001 and (NSF 61) quality control standards.

PTG 3 MEDIA PROPERTIES

Unless otherwise stated in the Project Specification, the purpose of the GAC media will be to adsorb taste and odour compounds in a water treatment process and to facilitate and sustain biological activity on the GAC media to assist in the removal of DOC and taste and odour compounds.

PTG 3.1 Virgin GAC physical properties

The minimum requirements for GAC are listed in the table below. The Tenderer shall detail at tender stage each parameter as described below.

Parameter	Minimum Specification	Unit
Adsorptive capacity		
Iodine number	>1000	mg/g
Methylene blue	>250	mg/g
Surface area	>1100	m ² /g
Total pore unit volume	>1,0	cm ³ /g
Media density		
Apparent- and particle density	>460	kg/m ³
Bed density, backwashed and drained	>410	kg/m ³
Media moisture and ash content		
Wetability	>95	%
Moisture content	<5	%
Water soluble matter	<0.2	%
Total ash content	<15	%
pH	>8	
Media hardness and abrasion resistance		
Ball-pan hardness number	95	%

Table PTG-1 : Minimum GAC requirements

PTG 3.1.1 Media size

The Tenderer must indicate the size distribution of the GAC and indicate the typical filtration rates to be used for this carbon. The media size required is described in the Project Specification. Tenderers shall supply with their tenders the particle size distribution, effective stage and uniformly coefficient.

PTG 3.1.2 Adsorptive capacity

The tenderer must indicate the adsorptive properties of every GAC offered. The adsorptive capacity of the GAC will be assessed by means of the Iodine number and the Methylene blue number at tender stage.

PTG 3.1.2.1 Iodine number

The Iodine number is a measure of carbon activity level and a measure of the micropore content of the activated carbon by adsorption of iodine from solution.

PTG 3.1.2.2 Methylene blue number

Some carbons have a medium to large pore structure which adsorbs medium sized molecules, such as the dye Methylene Blue.

PTG 3.1.2.3 Geosmin and 2-MIB adsorption capacity

The adsorption capacity of each GAC offered will be tested for geosmin, 2-MIB and DOC removal by the Client. A 2,5 kg sampled of each GAC shall be supplied by the Tenderer.

PTG 3.1.3 Pore value and surface area

The Tenderer must indicate the pore volume and the unit surface area of the GAC offered.

PTG 3.1.4 Apparent and particle density of media

The Tenderer must indicate the apparent density, wetted density and the particle density of the carbon.

PTG 3.1.5 *Moisture content and watability*

The Tender must indicate the maximum moisture content as well as the watability of the carbon.

PTG 3.1.6 *Hardness*

Since the GAC will be exposed to a variety of external forces during transporting, loading into and out of adsorbers, backwashing a high hardness value will be favoured.

It is also the intention of the client to regenerate the GAC on site. For this purpose additional carbon handling, i.e. extraction, regeneration and re-packing of GAC filters will be required and will impose additional abrasion on the media.

PTG 3.1.7 *Ash content*

The total ash content and the water soluble ash content should be clearly stated.

PTG 3.1.8 *Impurities*

The GAC supplied shall contain no substances in quantities that can have deleterious health effects on consumers.

PTG 3.2 *Hydraulic properties*

The Tenderer must supply the Engineer with the hydraulic properties of the GAC as described below.

PTG 3.2.1 *Bed expansion*

The bed expansion rate during backwashing shall be given for backwash velocities from 10 to 50 m/h and included in the Tender.

PTG 3.2.2 *Head loss*

The clean media headloss shall be given for filtration rates between 4 and 10 m/h and included in the Tender.

PTG 3.3 *Regenerated GAC physical properties*

The expected percentage loss during regeneration should be indicated for each carbon offered.

PTG 4 *GAC SCREENING AND SELECTION*

PTG 4.1 After receiving four 24 kg GAC samples a number of tests will be conducted and the Client will select one or more preferred GAC products. The Contractor will be given an instruction which GAC to supply.

PTG 5 *GAC TESTING, GUARANTEES AND REJECTION*

For each shipment and type of GAC random samples will be taken from the GAC bags to verify that the GAC conforms to the GAC specifications.

Contractor

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Employer

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June 2025

PTG 5.1 GAC testing requirements

Each Contractor will be required to supply a 25 kg sample of four different types of GAC that meets the requirements of the GAC media specification detailed in Table PTG-1. The sample supplied shall conform to the requirements of AWWA 604:06.

Each sample will be tested to verify conformance to the guaranteed performance and specification.

PTG 5.2 Guarantees

The Tenderer shall guarantee the performance of the GAC.

PTG 5.3 Rejection

Failure to meet the guaranteed performance can result in a rejection of the GAC shipment.

PTG 6 SHIPPING, PACKAGING, STORAGE, TRANSPORT AND DELIVERY

PTG 6.1 Shipping

The Contractor will not be allowed to skip any GAC prior to the completion of the testing as described in PTG 4.1. The Contractor will be notified in unity which GAC have been selected and which GAC can be skipped.

PTG 6.2 Consignment

The Contractor shall submit to the Engineer an advice note in duplicate immediately before any consignment of goods ordered has been dispatched. Such advice note shall fully describe the goods so dispatched and shall state the date of dispatch and provide full information of the anticipated date of arrival at the point of delivery. If the GAC are to be dispatched by sea the date of arrival at a South African port and the name of the ship shall be stated. The Contractor shall remain responsible until the GAC is delivered to the Site of Works.

PTG 6.3 Labelling and packaging

PTG 6.3.1 When any GAC is transported and stored the Contractor shall:-

- (a) Label and mark the GAC or the packaging or crates in which they are packed so as to identify the GAC as the property of the Employer;
- (b) Be responsible for packing the GAC, so as to ensure that no deterioration thereto takes place whilst the GAC are in storage and shall be fully responsible for making good at his own expense, to the satisfaction of the Engineer, any deterioration or damage which, in the opinion of the Engineer arises from any cause other than the fault or decision of the Engineer (or its servants) and for the purpose of this sub-clause, any opinion or decision of the Engineer in regard to the question of the fault or otherwise of the Employer or its servants shall be final and binding on all the parties to this Contract notwithstanding anything to the contrary stated elsewhere in this Contract.

PTG 6.3.2 Ownership of packaging material

Packing cases and packing material shall be and remain the property of the Employer except where the Contractor delivers to Site in his own vehicle, unloads, installs and commissions.

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PTG 6.4 Storage

The Contractor shall store the GAC in suitable premises provided by the Contractor and approved for the purpose by the Engineer.

PTG 6.5 Transport

The Contractor shall remain liable for physical delivery of the GAC stored to the Works.

PTG 6.6 Delivery

The Contractor shall be required to deliver the GAC to the site described in the Project Specification. The Contractor shall deliver the GAC on time as per the predetermined delivery schedule. The delivery point will be specified by the Employer. The Contractor will be responsible for any damages caused to the GAC, equipment and surrounding buildings by the delivery and placement of the GAC.

PTG 6.7 Media placement

The GAC Contractor will not be required to place the media. The Contractor responsible for the installation of the GAC filters shall place the media in horizontal layers within 5% of the specified thickness. The level and thickness can be controlled by letting water into the filter box after each layer is placed.

PTG 7 OCCUPATIONAL, HEALTH AND SAFETY REQUIREMENTS

All apparatus and material supplied and all work carried out shall comply in all respects with the Occupational Health and Safety Act as well as the risk posted at AWWA 604-05 and the Safety Specification. Act No 85.

The Contractor shall be responsible for any damage caused by fire and must assure that his activities are safeguarded against possible fire hazards. The Contractor shall also be responsible to ensure sufficient ventilation and dust suppression at the time of loading and off-loading GAC.

PTG 8 PRICING

PTG 8.1 Unit cost of carbon

The unit cost of carbon, per kg and per m³ must be clearly indicated. This cost will be the unit cost of the carbon delivered to Site and stored in a storage room on site and will include the price ex works manufacturing, shipment cost, docking and all duty fees, rate of exchange forward cover, transport cost and handling cost to Site.

PTG 8.2 Payment

The conditions of payment and the rate of exchange at which the GAC is offered needs to be specified.

PTG 8.3 Validity of offer

The validity of the offer shall be at least 90 days from close of tender.

PTG 8.4 Delivery Lead Times

The delivery dates and shipment volumes need to be specified from the date of Letter of Acceptance.

END OF SECTION

Contractor

Witness 1

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

PTO : OZONE EQUIPMENT

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PTO 1 GENERAL EQUIPMENT AND CONTRACTOR INFORMATION

PTO 1.1 Equipment standards and reliability

In order to guarantee the highest manufacturing standards of the ozone equipment offered, the ozone Supplier must be ISO9001:2000 certified at date of tender. All equipment and systems supplied shall be in conformity with ISO and IEC standards. A copy of the certificate shall be included with the tender.

PTO 1.2 Contractor design, manufacture, installation and commissioning ability

In order to prove the design, manufacturing, installation and commissioning ability of the Supplier references of least 5 ozone installations shall be provided. The reference list shall include the following:

- Plant name
- Country of installation
- Production capacity
- Maximum ozone concentration
- Oxygen source
- Year of commissioning

In order to establish the equipment reliability the Supplier shall submit the following additional information for the reference plants:

- No of electrode failures per installation per year
- Other equipment failures
- The mean time between failure (MTBF) and total number of ozone generator failures during the past three years.
- Estimated breakdown maintenance cost as % of initial capital cost

PTO 1.3 Contractor local presence and support ability

The Supplier must have at least 2 reference plants in South Africa. The reference list shall include the following:

- Plant name
- Production capacity
- Maximum ozone concentration
- Oxygen source
- Year of commissioning

PTO 2 GUARANTEES AND PENALTIES

The Supplier shall provide a 12 month guarantee on all equipment supplied. The guarantee period shall commence on the successful completion of the Wet Commissioning.

The Supplier shall guarantee the performance of the equipment according to the following performance requirements and at the ozone generator duty points specified in the Project Specification.

PTO 2.1 Ozone production

The ozone production in kgO₃/h measured at the specified duty points.

<div></div> <div>Contractor</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>	<div></div> <div>Employer</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>
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PTO 2.2 Power consumption

The specific power consumption in kWh/kgO₃ and total power consumption in kW, measured at the specified duty points. The measurement shall include all equipment required to operate the ozone system to achieve the performance at the required duty points and shall include all ancillary equipment such as cooling water pumps.

PTO 2.3 LOX consumption

The specific LOX consumption in kgO₂/kgO₃ generated as well as the total LOX consumption in kgO₂/h, measured at the specified duty points.

PTO 2.4 Ozone system reliability

The ozone system MTBF shall be specified. This will include all items related to the ozone generation including cooling water system, instruments, ozone supply and ozone generator equipment,

PTO 2.5 Corrosion Protection

All equipment shall be guaranteed against corrosion for 10 years.

PTO 2.6 Penalties

PTO 2.6.1 Penalties for not meeting the unit power and LOX consumption

Should the Supplier exceed the unit power consumption or the unit LOX consumption as stated in the guaranteed figures, liquidated damages will be payable. The liquidated damages will be calculated as the net present worth of cost difference between the guaranteed and the actual operating LOX and energy costs based on a 10 year operating period, a discount rate of 6% above the prevailing CPIX at the time of tender, and the unit LOX and energy costs applicable to the Site as stated in the Project Specification.

PTO 2.6.2 Penalties for not meeting the guaranteed ozone production rate

Should the guaranteed production rate not be achieved at the required ozone concentration, the ozone generator will be operated at a reduced ozone concentration until the guaranteed ozone production rate is achieved. Liquidated damages will be calculated as the net present worth of cost between the original guaranteed operating cost and the operating cost (LOX and energy) required to meet the guaranteed figure. The basis for the calculation will be as per PTO 2.6.1.

PTO 3 GENERAL TECHNICAL REQUIREMENTS OF OZONE SYSTEM

Technical requirements of the ozone system offered are categorized as follows and specified separately below:

- Oxygen production sub-system (PTO 4)
- Ozone generation sub-system (PTO 5)
- Instrument air sub-system (PTO 6)
- Nitrogen bleed sub-system (PTO 7)
- Cooling water sub-system (PTO 8)
- Side stream diffusion and degassing sub-system (PTO 9)
- Bulk ozone diffusion sub-system (PTO 10)
- Vent off-gas obstruction sub-system (PTO 11)
- Piping, fittings and valves for each sub-system (PTO 12)

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Witness 2

- Instrumentation and control sub-system (PTO 13)

The battery limits for each sub-system is described in the Project Specification.
The Supplier shall offer the design, obtaining approval of the Employer, procurement, manufacturing, testing, delivery, storage, erection supervision, commissioning and technical training, provision of as-built drawings, operation and maintenance manuals, special tools and spare parts of a complete and integrated ozone system.

PTO 4 OXYGEN PRODUCTION EQUIPMENT

PTO 4.1 LOX equipment and oxygen quality

The oxygen source shall be from a local LOX cryogenic tank supplied by a separate gas supplier. The LOX installation shall include a LOX tank with two evaporators each sized to vaporise the 50% maximum amount of oxygen specified in the Project Specification. The LOX equipment shall be installed and maintained by the LOX supplier up to the LOX installation fence as indicated on the process flow diagram. The ozone equipment supplier shall be responsible to coordinate the connection to the LOX supplier battery limits.

The quality of the LOX will contain at least 99.5% oxygen. A suitably sized nitrogen source shall be supplied and installed by the ozone equipment supplier as specified in PTO 7.

PTO 4.2 PSA equipment and oxygen quality

In the case where the Tenderer can demonstrate that a Pressure Swing Adsorption (PSA) unit is more cost effective compared to a LOX system, the PSA system shall be priced in full as an alternative. The PSA system must include all related air preparation equipment such as oil free compressors, refrigerant and desiccant dryer units, air receivers, oxygen receivers, dew point monitors, filters and all associated instrumentation.

The PSA unit shall be sized to produce oxygen at the maximum oxygen feed rate required by the ozone generator. The MTBF of the PSA needs to be specified and guaranteed.

The oxygen supplied from the PSA units shall be >95% (m/v), dry with a dewpoint of less than -70°C, clean and comply in all respects with the oxygen requirement of the ozone generator equipment supplier.

When calculating the net present worth of cost of a PSA unit, a figure of 15% of the initial capital cost will be used for annual maintenance expenditure.

PTO 5 OZONE GENERATION EQUIPMENT

PTO 5.1 Ozone Generation vessel

The ozone generation vessel shall be installed in a horizontal position to allow easy observation and accessibility for maintenance purposes.

PTO 5.2 Material

All material in contact with ozonated gas and cooling water must be manufactured from stainless steel grade 316L. The stainless steel tubes containing the dielectrics must be seal welded to the tube sheet.

The ozone generator must be constructed with baffled cooling water sections made of high-grade 316Ti (DN 1.4571) stainless steel. The Tenderer shall indicate dielectrics tube guarantees.

Ozone resistant material must be used for all parts and components of the ozonators and plant that will come into contact with ozone gasses or their hydrous solutions. The Tenderer shall indicate the ozonator corrosion guarantee should it vary from the guaranteed period stated in PTO 2.5.

PTO 5.3 Electrodes

The working voltage of the dielectric must be less than 20% of the break down voltage.

Each dielectric must be factory tested before installation in the ozone generator at at least twice the maximum operating voltage. The testing procedure must be submitted. The dielectric material shall preferably be of the non-glass high endurance thermal and shock resistant quality. The number of tubes in each ozone generator must be indicated. The design shall use a minimum of tubes in order to ease maintenance works.

Material of spacers must be indicated and should be designed to be reusable. Teflon spacers glued to the tubes that cannot be reused are not the recommended solution. The electrical stress applied to the dielectrics must be limited to increase the dielectric lifetime. The max. operating voltage must not be higher than 4000 V

PTO 5.4 Emergency shutdown

The ozone generator must have a main power circuit breaker sized to protect the ozone generator. An emergency switch located on the front panel of the unit will shut down the system on case of an emergency.

The system must allow instantaneous emergency shut down and removal of electrical power in the case of emergency

A local visual alarm must announce the automatic shut down of the ozone generator due to failure or violation of protective devices.

PTO 5.5 Power factor and power quality

The power factor at the main side of each power supply unit (PSU) for each ozone generator must not be lower than 0.98. The equipment offered shall be fitted with the necessary filters to prevent the feedback of harmonics into the local reticulation system.

PTO 5.6 Power supply unit

Thyristor based technology or main side IGBT based technology are the only acceptable systems to be supplied in order to reduce harmonics to a minimum. The total harmonics for the whole system must be less than 5% and fulfil international stand IEEE 519. Suppliers are to attach reference lists of installations where such systems have been installed with indication of country, plant name, ozone production capacity, ozone concentration and contact details.

Each PSU must have a PLC and MMI operator panel for the control and monitoring of the generator functions (including acceptance of various signals from external safety pics for and operating instrumentation, sequential start up and shut down operations, ozone output control and emergency shut down) as well as associated valves and instruments and allow remote control by the ozone plant control PLC.

Each ozone generator PLC shall be compatible with the existing PLC system in use at the plant and shall have an addressable block for integration with the existing PLC network and SCADA system.

PTO 5.7 Auto/manual and local/remote control

The system must allow the selection of manual or automatic control of ozone output.

Activation/Deactivation of the ozone generation unit from the local control panel or from a remote location must be possible.

The ozonators shall have their own dedicated control and power distribution cabinets, with controller, man machine interface, relay switches and ancillary equipment. The tenderer shall provide an I/O-list of all his equipment with this tender.

PTO 5.8 Generator turn down ratio

The tenderer must indicate the turndown ratio of the ozonators.

PTO 5.9 Ozone generator design

PTO 5.9.1 The ozone generator shall be designed to meet the required production rate at 10% wt ozone gas concentration with a cooling water temperature of 25°C as specified in the Project Specification.

PTO 5.9.2 The ozonator must be complete, fitted to base frames for indoor erection, including all safety devices, instrumentation, cooling water pumps, PLC control unit, associated switching cubicles and ancillaries not specified, but required to install the equipment and operate the equipment safely while meeting the duty points.

PTO 5.10 Ventilation and Air Conditioning

The ozone supplier shall include sufficiently sized air conditioning and ventilation equipment in order to maintain a safe ozone generator room temperature and air quality.

PTO 6 INSTRUMENT AIR EQUIPMENT

Instrument air must be dried air (atmospheric dewpoint < -20°C), free of oil and dust. A refrigerant dryer and filter shall be provided to ensure that the air is dry and clean.

PTO 7 NITROGEN BLEED EQUIPMENT

The nitrogen bleed equipment shall consist of one of the following systems:

- A nitrogen source in the form of a cryogenic nitrogen cylinder with the appropriate vaporising equipment suitably sized to ensure a maximum nitrogen concentration of 25% (m/v) at the maximum GOX flow rate. The cryogenic tank shall be supplied with a level sensor and the appropriate pressure and flow control valves to control the the nitrogen bleed ratio.
- An air compressor system with air receivers, air filters, refrigerant and desiccant dryers, flow and pressure control valves and a dewpoint analyser. The nitrogen systems shall maintain a dewpoint of less than -70°C and controlled to a preset nitrogen bleed ratio.

PTO 8 COOLING WATER EQUIPMENT

The cooling water pumps shall form an integral part of the ozone system and be interlocked with the safety devices of the ozone generator. At least 50% standby capacity shall be provided. Pumps shall be 4 pole motor speed or lower.

The contractor shall satisfy himself with the suction and delivery conditions and shall ensure that the pumps are sized to meet the maximum cooling water flow rate. The NPSH at 0% headloss required PLUS 30% shall not exceed the NPSH available at the maximum flow rate and the minimum level of the tank from which the cooling water is abstracted. Pumps shall also be selected to run +/- 20% from BEP at all times.

The cooling water flow rate shall be adjustable by switching one cooling water pump on for each operational ozone generator. One additional standby pump shall be provided for every standby cooling water pump.

Each cooling water pump shall be equipped with a suction and delivery valve, non-return valve, suction and delivery pressure gauge and switch as well as a flow switch.

The cooling water system shall be fitted with two separate filters that can be isolated independently for cleaning as indicated on the process flow diagram. Cooling water equipment shall be manufactured from 316 stainless steel.

PTO 9 OZONE BUBBLE DIFFUSION EQUIPMENT

PTO 9.1 General

The scope of the bubble diffusion equipment shall include all pipe work, valves and actuators, instruments, fittings from the ozone generator building up to and including the dosing points. All pipelines containing ozone gas or dissolved ozone will be of 316L or 316Ti stainless steel. U tubes, condensate traps, non return valves and actuated electric shut-off valves will be required to prevent back flow and condensate in gas pipes.

PTO 9.2 Material and design

Ceramic dome diffusers suitably sized and spaced to meet maximum ozone dose requirements as specified in the Project Specification. Dome diffuser plates holders must be made from stainless steel 316 L and include orifice control nozzles with gaskets and caps. Porous discs shall be made from crystalline fused Al_2O_3 with a suitable ceramic bonding material, which is resistant to ozone attacks up to ozone concentrations of up to 14 percent by weight. The diffusers shall provide ozone-oxygen bubbles across their entire active section through the entire design flow range for the ozone system. The diffusers shall achieve a bubble size of 2 to 3 mm in diameter.

316 L stainless steel pipes and pipe manifold from ozone generator to dome diffusers including support brackets, bolts, couplings, supports, seals, valves, flow meters and other appurtenances. Pipelines shall be designed to prevent flooding of any part of the pipeline.

All piping, coupling, tees, ceramic diffuser housings, support equipment, tie-down nuts and bolts and hardware within the contact chambers must be made from Type 316L stainless steel. All gaskets for flanges and diffuser housings for the diffusion system must be PTFE to resist corrosion attack by ozone in water and oxygen.

Thermal mass flow meters and control valves to control the ozone dose to each diffuser compartment.

316 L stainless steel manual isolating valves on one each gas feed system, sampling lines and vent lines.

PTO 9.3 Efficiency

The ozone transfer efficiency shall be guaranteed to be more than 95%. One off-gas ozone analyser must be installed above each bubble diffuser compartment in order to monitor the instantaneous ozone transfer efficiency.

PTO 10 SIDE STREAM DIFFUSION AND DEGASSING EQUIPMENT

PTO 10.1 General

Existing structures shall as far as possible be re-used for the purpose of contact time and degassing. Should the existing contact time and degassing not be sufficient, the contactor shall indicate this requirement at the time of tender and propose an alternative structure.

PTO 10.2 Material and design

The side stream diffusion and degassing system shall include the following equipment:

- Motive water pumps
- Ozone injection and mixing device
- Degassing vessels (where necessary)
- Process and ozone piping
- Valves and fittings
- Instrumentation as described in the Project Specification.

Thermal mass flow meters and control valves to control the ozone dose to each ozone injection device.

The recycle stream shall be taken from and reintroduced in the main process as indicated on the process flow diagram and layout drawings. Only four pole motors will be allowed for recycle pumps.

Three recycle pumps, two duty and one standby pump shall be supplied. Each side stream injection part shall have at least a 50% turn down ratio. Two separate sidestream systems need to be provided in order to facilitate the required turn down ratio.

All piping, valves, pumps, flow meters and appurtenance shall be manufactured from 316L or 316Ti.

PTO 10.3 Efficiency

The ozone transfer efficiency shall be guaranteed and not be less than 85%. All material shall be manufactured for 316L or 316Ti.

PTO 11 VENT OFF-GAS DESTRUCTION EQUIPMENT

PTO 11.1 General

The residual ozone from vent gas from all ozone generation, mixing and contacting equipment shall be destructed by means of a thermo-catalytic ozone destructor before being vented to the atmosphere.

Contractor

6 PTO - Ozone Equipment - June25

Witness 1

Witness 2

Employer

Witness 1

Witness 2

June 2025

PTO 11.2 Ozone destructor

Each ozone destructor will be skid mounted and shall contain a catalytic bed where the decomposition of the ozone will take place. The catalytic unit shall be complete including demister, heater, catalyst, control panel and exhaust gas blower.

The heating and catalyst reaction chamber must be separated in order to increase lifetime of the catalyst material.

The ozone gas concentration leaving the ozone destructor must be lower than 0.1 ppm under all operating conditions.

The destructing system must be designed for remote control.

The destructing system including all piping, valves and appurtenances must be constructed from 316L stainless steel, except for the extract fan, located downstream of the heater, which will be made of aluminium or carbon steel.

PTO 11.3 Ozone off-gas analyser

One off-gas ozone detector must be installed downstream of each destructing unit in order to monitor the off gas concentration. In case the limit of 0.1 ppm is exceeded an alarm must be sent to the ozone plant control system.

PTO 12 PIPING, FITTINGS AND INSTRUMENTS

PTO 12.1 Material

The following specifications and requirements are applicable to the ozone piping, fittings and instruments:

PTO 12.1.1 Pumping and fittings

- Welded tubes of 316L or 316T must be used
- Execution must be according to DIN EN ISO 1127
- Tube tolerances must be according to DIN EN ISO 1127
- Material must be DIN 1.4404 / 1.4435 / 1.4571 (AISI 316L /316Ti)
- Surface finish of piping must be metallic bright
- PTFE gaskets must be used

PTO 12.1.2 Instruments

All instruments in contact with ozone gas or dissolved ozone shall be 316L stainless steel.

PTO 12.1.3 Design

In order to limit pressure losses and reduce noise emissions, the velocity in pipes shall be as follows:

- Oxygen pipes: <10 m/s
- Ozonated oxygen pipes: <8 m/s
- Vent ozone gas pipes: <6 m/s
- Water piping: <1.5 m/s

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PTO 12.2 Sizes and colour coding

Pipe sizes to be indicated on all pipes. Ozone gas and solution pipes to be colour coded with an adhesive tape colour band.

PTO 13 VALVES

All valves that are in contact with ozone gas is dissolved of 316L stainless steel and Teflon seals. The contractor shall provide details of valves and actuators to be used at tender stage as listed in table PTO 1.

Valve Type	Manufacturer	Material
Isolation valves (LOX)		
Isolation valves (GOX)		
Isolation valves (Ozone Gas)		
Isolation valves (Water)		
Isolation valves (Dissolved ozone)		
Flow control valves (Gas – ozone) (Gas – oxygen)		
Pressure reducing valves (Gas – ozone) (Gas – oxygen)		
Sampling line isolating valves		

Table PTO 1 – Valve manufacturer and material

PTO 14 ELECTRICAL PANELS

The supplier shall include in his supply and electrical panels required for the control of all the equipment of the ozone system including, but not limited to the following:

- Ozone generation
- Cooling water pumps
- Nitrogen fluid system
- Ventilation equipment
- Sidestream pumping equipment
- Hoisting equipment
- Destructuring equipment
- Instrumentation and control equipment
- Safety equipment

PTO 15 INSTRUMENTATION AND CONTROL EQUIPMENT

PTO 15.1 General

Instrumentation and control equipment shall be sufficient for the continuous monitoring of the ozone generation and contacting process as well as the control of dosing rates. A complete P&ID shall be provided with the tender indicating all associated pipe work, instrumentation and control equipment. The number and location of the instruments are detailed in the Project Specification.

PTO 15.2 Ozone generator control system

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Each of the ozone generators shall be equipped with an integrated ozone generation control system. The ozone generation control system shall control all aspects related to the ozone generation system and include:

- Power, gas feed, production and O₃ gas concentration control.
- Cooling water control.
- Control, monitoring and protection instruments.
- Displays, alarms, interlocks and trip.
- Startup and shutdown sequences.

The PLC used shall be compatible with the PLC used at the existing PLC network and the I/O shall be accessible in an accessible address block.

PTO 15.3 Ozone dosing control system

In addition to the ozone generator control system an ozone dosing control system needs to be supplied. The entire ozone system shall be fully automated and remote controlled by means of PLC, MMI and SCADA interfaces.

The control philosophy is based on the following inputs and control parameters:

PTO 15.3.1 Inputs selected by the operator via SCADA or MMI:

- Active dosing point(s)
- Applied ozone dosing rate required at each dosing point
- Operating ozone generators
- Required ozone concentration
- Unit energy cost
- Unit LOX cost

PTO 15.3.2 The SCADA system will provide the following:

- WTW production rate
- Water flow rate at each dosing point

PTO 15.3.3 The ozone dosing control system will perform the following:

- Calculate the required ozone production rate for the combination of the active dosing points
- Control the selected ozone generators to produce the ozone quantity required at a selected ozone concentration.
- Control the ozone mass flow rate to each of the dosing points within 5% of the required ozone mass flow rate.
- Select the number of operating cooling water pumps.
- Monitor the ozone off-gas to determine the ozone transfer efficiency.
- Monitor the residual ozone concentration at positions described in Project Specification.
- Calculate unit energy cost of O₃ production in R/kg O₃.
- Calculate disinfection CT value based on residual O₃ concentration measurements, flow rates and given hydraulic efficiency.

PTO 15.4 The following data shall be displayed on the local MMI or SCADA system:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

6 PTO - Ozone Equipment - June25

PTO-10

June 2025

Ozone monitoring system

General Plant Data

- Plant flow rate

LOX equipment

- LOX tank level and mass of oxygen in tank
- Oxygen concentration

Nitrogen bleed equipment

- Nitrogen system status (compressor, dryer, feed valve position)
- GOX/nitrogen mixture dewpoint

Ozone generator equipment

- Ozone generator status
- GOX mass flow rate to each ozone generator
- Ozone concentration in gas phase
- Ozone power consumption
- Temperature of cooling water
- Cooling water flow rate

Dosing equipment

- Dosing point status
- Ozone mass flow rate to each dosing point
- Ozone off-gas concentration at dosing points
- Ozone transfer efficiency
- Ozone residual concentration from all online instruments
- Sidestream pumping rate and starters

Destructor equipment

- Destructor unit status
- Ozone concentration after destruction/alarm

PTO 16 INSTRUMENTATION

PTO 16.1 Permanently Installed Instruments

The ozone system shall as a minimum include the instrumentation as detailed in Table PTO-2 below. The number of instruments required is specified in the Project Specification.

Area	Instrument type	Indicator	Transmitter	Totalizer	Alarm		Switch	
		I	T	N	AL	AH	SL	SH
Oxygen supply	Dew point	x	x			x		x
	Temperature	x	x					
	Pressure	x	x		x	x	x	x
	Oxygen concentration	x	x					
Nitrogen bleed system	Oxygen concentration	x	x					
	Pressure	x	x		x			
	Dew point	x	x			x		
Ozone generation (per generator)	Mass flow	x	x	x				
	Temperature	x	x					x
	Pressure	x	x				x	x
	Ozone gas concentration	x	x					
	Ozone generator room O ₃ concentration	x	x		x			
Ozone contacting (Bubble diffuser) (per system)	Mass flow	x	x	x				
	Ozone residual concentration	x	x					
	Ozone gas concentration	x	x					
	Level	x	x					
Ozone mixing (Sidestream mixing) (per system)	Mass flow	x	x	x				
	Ozone gas concentration	x	x					
	Ozone residual concentration	x	x					
	Pressure	x	x					
Ozone destructing (per system)	Ozone gas concentration	x	x			x		
	Pressure	x	x			x		
Hand held Instruments	O ₃ Gas	x	x					
	O ₂ Gas	x	x					
	O ₃ Residual	x	x					

Table PTO -2: Ozone system instrumentation requirements

PTO 16.2 Portable Instruments

The Contractor shall supply the following portable equipment:

- Residual ozone analyzer (photometer type)
- O₃ gas analyzer (low concentration type)
- ORP analyzer

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PTO 17 PLC and SCADA requirements

All PLC's supplied with the ozone system shall be compatible for integration into the existing/planned plant SCADA system.

A PLC system with a MMI must be supplied to control the ozone plant and to allow automatic monitoring and remote control of the following ozone equipment, including:

- LOX system
- Nitrogen system
- Ozone generating system
- Cooling water system
- Instrument air system
- Side stream injection system
- Bubble diffuser system
- Vent ozone destruction system
- Other plant inputs and controls

The process of the ozone system must be visualized on the operator SCADA system and local MMI.

PTO 18 TESTING AND COMMISSIONING

PTO 18.1 Works test (factory acceptance test)

All ozone generation equipment shall be tested before shipment/transport at the manufacturer's premises. The Tenderer shall include in his cost the cost of the Employer and the Employer's Representative to witness the acceptance test. Six weeks notice shall be given prior to the acceptance test.

The following performance aspects shall be demonstrated during a 24 hour acceptance test.

- Total power consumption of each ozone generator measured at 6%, 8%, 10% and 12% ozone concentration at maximum power output.
- Ozone production rate at the abovementioned operating points.
- LOX feed rate at above operating points.
- Any other duty point specified in the Project Specification.

The ozone supplier shall use the data collected during the acceptance test to 'finger print' the ozone generator characteristics in terms of:

- Ozone production rate vs LOX consumption (with nitrogen source)
- Ozone production vs energy consumption
- Ozone production vs cooling water temperature

The ozone generator characteristics will be used during the commissioning period to optimise the ozone generating operating cost.

PTO 18.2 Site performance test

The following performance tests shall be performed on site at the nominal production rate of the plant:

Ozone generation

- Power consumption at duty points and maximum power consumption
- LOX feed rate at duty points and maximum gas flow rate

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Ozone production rate at duty points and maximum ozone production rate
- GOX concentration at duty points (after nitrogen source)
- Nitrogen bleed system production rate and quality at duty points and maximum ozone production rate
- Dew point at duty points

Ozone contact system

- Maximum gas transfer rate
- Bubble distribution uniformity at minimum duty point and maximum gas flow rates
- Ozone off-gas concentration at maximum duty point and gas flow rate
- Ozone transfer efficiency at minimum duty point and maximum gas flow rates
- Ozone dosing control accuracy at minimum and maximum gas flow rates

Ozone mixing system

- Recycle pumping rate at minimum duty point and maximum ozone dosing rates
- Ozone off-gas concentration at duty point and maximum gas flow rate
- Ozone transfer efficiency at minimum duty point and maximum ozone dosing rates
- Ozone dosing control accuracy at minimum and maximum ozone dosing rates

Ozone destructing system

- Ozone vent gas concentration at duty point and maximum gas flow rate

PTO 19 SPARES AND MAINTENANCE AGREEMENT

PTO 19.1 The Tenderer shall determine the critical spares and indicate the costing of the required spares for servicing and maintaining the installed equipment for a period of at least two (2) years and indicate the details in the Technical Schedules and Bill of Quantities.

PTO 19.2 The Tenderer shall submit and indicate costing for a preventative maintenance contract, which will commence after expiry of the factory warranty period.

PTO 20 TRAINING

PTO 20.1 A qualified engineer trained and approved by the manufacturer shall take full responsibility for installation, commissioning, and final hand-over of the ozone plant to the Employer. The Tenderer must also make provision for training the operating and maintenance staff on site.

PTO 20.2 An outcome based on-site training programme shall be developed by the ozone supplier and submitted to the Engineer for approval.

PTO 21 ADDITIONAL/ALTERNATIVE REQUIREMENTS

Tenderers are required to indicate any limitations, alterations or required operating procedures applicable to the equipment offered and the structures indicated on the Tender Drawings.

PTO 22 OCCUPATIONAL HEALTH AND SAFETY REQUIREMENTS

The Contractor shall ensure that all equipment are designed and installed in accordance with the safety requirements of the ozone equipment supplier and the Occupational, Health and Safety (OHS) Act and its regulations.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTO 22.1 Ambient Ozone gas analyzers

The Contractor shall provide a ambient ozone gas monitor and alarm system for monitoring the indoor ozone concentration in the following areas:

- Ozone generating room
- Any other confined or semi-confined space where operator will often be required to sample

Each ozone gas monitor shall alarm level shall be set to the maximum allowable concentration (MAC) value for the ozone as required by the OHS Act. An alarm and flashlight shall be activated if the MAC level is exceeded at the entrance of the area.

PTO 22.2 Breathing apparatus set

Two sets of self contained breathing apparatus shall be supplied with sufficient storage capacity of at least 10 minutes complete with face mask and pressure regulator.

PTO 23 MEASUREMENT AND PAYMENT

PTO 23.1 General

Tendered prices shall include the following items (where applicable) unless otherwise stated in the Project Specification.

PSA equipment (if required)	sum
LOX equipment (if required)	sum
Nitrogen bleed system	sum
Ozone generator	sum
Cooling water system	sum
Bubble diffuser system	sum
Side stream diffusion and degassing system	sum
Vent off-gas destructor system	sum
Pipework and valves	sum
Instrumentation and control equipment	sum
Portable instruments	sum
Ozone factory acceptance test	sum
On-site performance testing and commissioning	sum
Spares and special tools (optional)	sum
Training	sum
Ozone support agreement (optional)	sum per year

Measurement and payment will be done in accordance with the methods stated below:

PTO 23.2 Design, Drawings and General

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

PTO 23.2.1	Provide design drawings and design information as specified.	Sum
-------------------	--------------------------------------------------------------	-----

PTO 23.2.2	Provide operating and maintenance manuals and “as built” drawings as specified.	Sum
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PTO 23.3 Supply and Delivery to Site

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTO 23.3.1	Supply and delivery equipment as specified in PTO 23.1	Sum
PTO 23.4	Installation Work	
	<i>Pay Item</i>	<i>Unit</i>
PTO 23.4.1	Install equipment as specified in PTO 23.1	Sum
PTO 23.5	Commissioning	
	<i>Pay Item</i>	<i>Unit</i>
PTO 23.5.1	Commissioning equipment as specified in PTO 23.1.	Sum
PTO 23.6	Provision of additional spare equipment	
	<i>Pay Item</i>	<i>Unit</i>
PTO 23.6.1	Supply and delivery of specified equipment to the store facility of the Employer	Sum

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PT: PUMPS

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PT PUMPS

PT 1 SCOPE

This section of the Specification includes the manufacture, testing, protection, supply and off-loading of pumps and base-plates used for the pumping of raw or potable water at ambient temperatures as stated. Pump duties shall be in accordance with the Project Specifications. Electrical motors do not form part of this section of the Specification. This section of the Specification must be read in conjunction with the Project Specification.

This general specification shall be applicable to all pumps. Additional requirements for submersible pumps, axial flow pumps and self-priming-type centrifugal pumps, if required, have been included under clauses PT-7, PT-8 and PT-9.

PT 2 INTERPRETATIONS

PT 2.1 Abbreviations

For the purposes of this Specification the following abbreviations will apply:

BS	-	British Standards Institution
SABS	-	South African Bureau of Standards
DIN	-	German Standards Institute
ISO	-	International Organisation for Standardisation
SIS	-	Swedish Standards

PT 2.2 Standards

Pumps shall comply with this Specification and with the current and most recent issues of the following standards where applicable:

BS 970	Wrought steel in the form of blooms, billets, bars and forgings
BS 1400	Copper alloy ingots and copper and copper alloy castings
BS 3100	Specification for steel castings for general engineering purposes
BS 3468	Austenitic cast iron
BS 4360	Specification for weldable structural steel
BS 4675	Mechanical vibration in rotating and reciprocating machinery
BS 4999	General requirements for rotating electrical machines
BS 5316	Acceptance tests for centrifugal, mixed flow and axial flow pumps
ISO 9906	Hydraulic performance tests of centrifugal pumps
BS 4504	Flanges and bolting for pipes, valves and fittings

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

SABS 1123 Steel pipe flanges

SIS 05 59 00 Pictorial surface preparation standards for painting steel surfaces

PT 3 MATERIALS

PT 3.1 General

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document, comply with the requirements of the most recent edition of the appropriate South African or other internationally recognised standard specification.

For each type of equipment, the Manufacturer shall indicate the materials used for each of the proposed sub-assemblies. The equipment shall be manufactured using new prime quality materials taking into account the latest technical innovations.

All components shall have a surface finish in relation to their importance, their position and their intended purpose.

Rolled steels and all castings shall be clean and free of blisters, porosity, shrinkage, holes, cracks or other flaws that may be detrimental to their use.

The Tenderer shall indicate in his tender the proposed materials for each component of the assembly.

PT 3.1.1 Castings

No repair of cast components will be permitted without the prior approval of the Engineer.

The filling of casting defects shall be carried out by approved highly qualified welders only, according to approved welding techniques.

Any cast component requiring filling at any fabrication stage after the first anneal shall be subjected to further annealing treatment unless stipulated otherwise.

Cast components shall not be warped or distorted in any way and shall not show any increase in dimensions (beyond that shown on the fabrication drawings) likely to cause interference with other components in the erection of the item of equipment for which they were made. The structure of cast components shall be homogeneous and free of non-metallic impurity. If, at critical points of a cast component, there is too great a concentration of impurities, the component shall be rejected.

PT 3.1.2 Pump Casings

Pump casings shall be of cast iron of at least Grade 220 to BS 1452 or stronger cast steel. The grade of material proposed should be selected appropriate to the quality of water to be pumped as specified in the Project Specification.

PT 3.1.3 Impellers

Impellers shall be cast in either phosphor bronze (PBI according to BS 1400 or 1C according to SABS 200), aluminium bronze (AB1 according to BS 1400 or 1E according to SABS 200) or chrome steel (316C11 according to BS 3100, or DIN1.4313), unless otherwise specified in the Project Specification. Cast iron or leaded gunmetal shall not be permitted. Bronze components shall be zinc-free.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2
June 2025

PT 3.1.4 *Pump Shafts*

Pump shafts shall be of EN 26 steel to BS 970 or similar.

If a Tenderer wishes to propose an alternative material this should be motivated with details of the benefits to be achieved.

PT 3.1.5 *Stainless Steel*

The stainless steel used shall be of the type easily jointed or fitted by electric welding. Stainless steel which cannot withstand the effects of welding or associated heat treatment will not be accepted. Austenitic grade stainless steel is preferred.

PT 3.1.6 *Fasteners*

Fasteners shall be stainless steel unless otherwise specified.

All high tensile bolts and studs used shall bear the letters 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 cleaned and coated with a graphite/grease, copper based or other approved compound before assembly. The threads of all bolts and studs used with the equipment supplied shall be to the same standard. The length of bolts should be such that at least two threads protrude beyond the nuts, but not more than four threads. The threaded end of all bolts must point to the downstream direction of flow.

The Tenderer shall indicate in his tender the materials proposed for each part of assembly.

PT 4 *PLANT*

The Tenderer shall satisfy the Engineer of the sufficiency of the manufacturer's workshops to handle the manufacture, testing and protection of the pumps strictly in accordance with the Specification.

PT 5 *MANUFACTURE*

PT 5.1 *General*

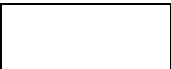
PT 5.1.1 Preference will be given to Pumps with a shaft rotational speed not exceeding 1500 r/min.

PT 5.1.2 Pumps shall be of the highest quality and suitable for continuous operation over long periods with the minimum of maintenance at high sustained efficiency.

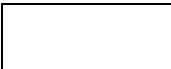
PT 5.1.3 End-suction pumps constructed on the back pull-out principle shall be provided with spacer pump motor couplings to enable the pump bearing housing, shaft and impeller to be removed without disturbing the pipework or alignment.

PT 5.1.4 The proposed layout of the pump station is indicated on the drawings accompanying the tender documents. They shall be studied carefully and all alterations to the lay-out, pipework or buildings required to suit the pump offered, shall be set out clearly in letters and drawings accompanying the tender offer. The final layout shall be agreed upon by the Contractor and the Engineer prior to the commencement of manufacture of any of the equipment. Complete work drawings shall be supplied by the Contractor for approval.

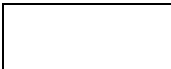
All equipment offered as well as all work carried out, shall comply fully with the requirements of the Occupational Health and Safety Act 85/1993 and the Machinery and Operational Safety Act 6/1983.



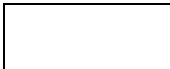
Contractor



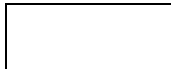
Witness 1



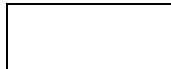
Witness 2



Employer



Witness 1



Witness 2

- PT 5.1.5** Taking into consideration specific speed calculations, efficiencies and reliability of the pump sets the proposed pump types shall be justified in the Tender. Double-Suction Axially Split Casing Pumps will be preferred unless otherwise specified in the Project Specification.
- PT 5.1.6** Arrangements incorporating multiple pump units coupled in series to achieve the duties specified in the particular specifications will not be favourably considered unless otherwise specified.
- PT 5.1.7** The arrangements of impellers shall be such as to reduce the residual axial thrust to a minimum. Designs incorporating a double suction will be preferred.
- PT 5.1.8** A design and arrangement of the pump casing which ensures that it is not necessary to disconnect the delivery pipework for the purpose of removing or replacing the complete rotating element will receive favourable consideration.
- PT 5.1.9** Suction and delivery details: The orientation of the suction and delivery pipes shall be such as to facilitate maintenance whilst being designed for minimum losses and no air traps.
- PT 5.2 Pump Characteristics**
- PT 5.2.1** The pumps shall have stable, non-overloading characteristics. Closed valve pressure shall be at least 25% higher than the duty pressure.
- PT 5.2.2** The Tenderer shall submit with this Tender for each pump offered the following characteristic curves:
- with respect to flow (in l/s)
- total head; in metres (0% to 120% of duty flow)
 - power absorbed; in kilowatts (50% to 120% of duty flow)
 - efficiency; (0% to 120% of duty flow)
 - net positive suction head (NPSH) requirements: recommended, 0% head drop, and 3% head drop relative to pump shaft centre line, in the case of horizontal spindle pumps;
- with respect to speed:
- torque requirements rated in absolute units.
- PT 5.2.3** The Contractor may be called upon to provide further curves at the request of the Engineer, especially for starting and stopping analysis, in connection with surge analysis in the rising mains.
- PT 5.2.4** The efficiency curve shall be flat over a wide range in order to provide efficient working with various pump operating conditions. It shall conform to the requirements of the Project Specification.
- PT 5.2.5** Unless specified to the contrary, the proposed pumps shall be able to operate without perceptible signs of cavitation in the full range of the operating envelope specified, pump sets running singly or in parallel. Throttling shall not be allowed. Should there be any doubts, the Contractor shall be called upon to carry out an inspection of the pumps and carry out NPSH tests to prove the equipment, at the Contractors expense. If the pumps are found to be faulty,

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the Contractor shall be given a 8 weeks to remedy the problem. Thereafter if the Contractor is unable to resolve the problem it shall be cause for rejection.

PT 5.3 Pump Castings

PT 5.3.1 No welding, burning, filling or plugging of defective castings shall be permitted without the Engineer's permission in writing, following an inspection of the defects.

PT 5.3.2 The inspection and testing of castings and test bars shall be in accordance with BS 3100.

PT 5.3.3 The dimension and drillings of the suction and discharge flanges integral with the pump casings shall be to SABS 1123 to design pressures specified.

PT 5.3.4 The pressure rating of the delivery flanges shall be at least equal to the maximum suction static pressure, plus the pump shut-off pressure. The minimum pressure rating of the flanges shall be 1 MPa (10 bar).

PT 5.3.5 All pump casings shall be hydrostatically tested at the Manufacturer's workshop and in the presence of the Engineer or his Representative. The test pressure applied shall be equivalent to 1,5 times the pump shut off head, or alternatively twice the duty head specified, which ever is the greater.

PT 5.3.6 Suitable lifting rings shall be provided on the casings.

PT 5.3.7 The pump casings should be fitted with suitable replaceable stationary bronze wear rings. These wear rings should be appropriately heat treated for operation in conjunction with the impeller, or impeller wear ring material selected.

PT 5.4 Impellers

PT 5.4.1 The castings shall be free of blow-holes and other defects. No welding, burning, filling or plugging of defective castings shall be permitted without prior approval being obtained from the Engineer in writing, following an inspection of the defects.

PT 5.4.2 All water passages shall be machined to a smooth finish. Water passages which cannot be machined shall wherever possible be hand ground and filed to template.

PT 5.4.3 Each impeller shall, after final machining and dressing, be independently statically balanced and the completely assembled rotating element with coupling shall be dynamically balanced.

PT 5.4.4 The first critical speed of the rotating element shall be at least 1,3 times the running speed.

PT 5.4.5 All impellers shall be fitted with wear rings of same material as approved for impellers. These rings shall be secured to the impeller non-corroding screws and be mechanically locked.

PT 5.5 Pump Shaft, Sleeves and Diffusers

PT 5.5.1 Pump shafts shall be of an approved material, and of sufficient dimensions to transmit the power to which they will be subjected without undue torsional or bending stresses and deflection.

PT 5.5.2 The shafts shall be stress-relieved after initial machinery, and ground to final size.

PT 5.5.3 The shafts shall be suitably designed for the reception of the impeller which shall be adequately secured to the shaft in such a manner as to be readily removable without damage to either the shaft or the impeller.

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- PT 5.5.4** The Contractor shall ensure that both the critical speed and torsional oscillation characteristics of the combined pump and motor rotating elements are satisfactory for all possible conditions of operation.
- PT 5.5.5** The shafts shall be adequately protected with replaceable sleeves of an approved bronze or other similar approved non-corrodible material at all areas where wear and/or corrosion could possibly be expected. The replaceable shaft sleeves exposed to the pumped water shall be manufactured from a material compatible with the impeller material selected. These sleeves shall be readily removable without causing damage to either the shafts or the sleeves.
- PT 5.6 Shaft Coupling**
- PT 5.6.1** The pump and motor shall be connected by a flexible coupling in such a manner that it shall not uncouple whichever way the impeller maybe rotating.
- PT 5.6.2** The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. Refer to PT8.3.
- PT 5.6.3** The coupling shall be enclosed in a stationary solid-plate guard to the Engineer's satisfaction.
- PT 5.7 Pump Bearings and Lubrication**
- PT 5.7.1 Bearings and Lubrication**
- If anti-friction bearings are fitted a design life of at least 40 000 operating hours is required. The bearings in the pump casing together with its lubricating systems shall be suitable for the particular circumstances. The particular type and system offered by the Tenderer shall be fully specified.
- PT 5.7.2** The pump rotating element shall be positively located in the axial direction. If specified, thrust bearings shall be of the tilting pad-type (Michell or similar).
- PT 5.7.3** Journal bearings consisting of white metal lined bronze sleeves split on the horizontal centre-line and lubricated with an oil ring shall be preferred.
- PT 5.7.4** All bearings shall be suitable for shaft rotation in both directions.
- PT 5.7.5** Preferably the same type of bearing will be chosen for motor and pump.
- PT 5.7.6** If not, the necessary allowance shall be made when aligning pump and motor.
- PT 5.7.7** Adequate provision shall be made for the cooling of oil for bearings, particularly as the pumps may run continuously in ambient temperatures of the order of 40°C.
- PT 5.7.8** Oil reservoirs of sufficient capacity shall be fitted with easily accessible oil level indicators, clearly marked to indicate the standing and running oil levels.
- PT 5.7.9** All internal surfaces in continuous contact with the lubricating oil such as oil reservoirs, piping, etc, shall be thoroughly cleaned either chemically or by shot blasting and protected by a method to be approved by the Engineer until such time as the system is charged with oil. No site welding of oil circulating pipes will be permitted.
- PT 5.7.10** The entire lubricating system shall be fail safe with alarms set to indicate automatic change-over to the stand-by unit.
- PT 5.8 Glands and Seals**

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PT 5.8.1 Reliability

Reliability of glands is of prime importance. Pumps incorporating low pressure glands where the pressure at the glands does not exceed the main suction supply pressure will be preferred to pumps with shaft glands exposed to higher pressures.

PT 5.8.2 Glands

Low pressure glands of the conventional stuffing box pattern utilising packing rings one each side of lantern rings will be acceptable for the first stage of the pumps. Lantern rings shall be easily removable. The shaft sleeves shall be ground with a polished finish on the wearing surface, and the gap between the sleeve and the follower shall be such that the packing will not be extruded into the gap. Make and type of packing shall be to the approval of the Engineer.

PT 5.8.3 It will be the responsibility of the Contractor to provide filters if the quality of the water necessitates filtration. The flow of water to or from the glands shall be clearly visible.

PT 5.8.4 Mechanical seals

If mechanical seals are called for, they shall require no separate water supply and shall be suitable for the water to be pumped. Seal selection shall be done in collaboration with the seal manufacturer and proof that this has been done may be requested.

If, in the opinion of the seal manufacturer, the quality of the water is such that a flush would be required to the seals, Tenderers are required to provide for a suitable system. Such a system shall be self contained and inclusive of all necessary separators, filters, connections and auxiliary pipe work to provide the required flow to the seals at the appropriate pressure. The auxiliary pipe work and fittings should be in a suitable grade of stainless steel.

Mechanical seals shall be balanced and proved to be suitable for the water pumped. Spare wearing components shall be supplied and delivered when the pump is installed, the cost being included in the price of the pump.

PT 5.8.5 The Tenderer shall supply with his Tender, full details of all pump seals and glands incorporated showing clearly all proposed materials, finished clearances, etc.

PT 5.9 Pump Vent and Drain Fittings

PT 5.9.1 Stainless Steel vent cocks shall be provided and fitted at all local high points on each pump casing. These cocks shall be of adequate size to enable the entrapped air to be released freely. Stainless Steel pipes shall be neatly led from priming cocks, gland and casing drain points to a suitable main tundish. Galvanised drainage pipeworks of adequate size shall be provided and installed to collect the waste water from each pumpset and to lead it to the drain leading to the pumphouse sump.

PT 5.10 Base-plate

PT 5.10.1 The pump and motor base-plate shall be rigid. The upper face of each base-plate upon which the pump and motor are located, shall be machined flat and smooth to ensure that the pump is supported properly directly to the base-plate, without the use of spacers. Provision must be allowed to align the motor correctly to the pump through the use of suitable shims or spacers, the combined height of which should not exceed 3 mm. Drawings of baseplates shall be submitted for approval before manufacture.

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PT 5.10.2 For every motor, two jacking bolts at right angles with a lock nut shall be provided at every corner.

PT 5.11 Monitoring Devices

PT 5.11.1 Unless specifically stated in the Project Specification, one or more of the following monitoring items shall be required:

Full details of the sensing equipment (thermocouples, etc.), and of the associated control and monitoring or indicating equipment shall be submitted with the tender offer. Evidence shall also be submitted that adequate spares and services are readily available in this country.

PT 5.11.2 Temperature Sensors

Either thermocouples or resistance temperature detectors shall be installed, depending on which is more suitable to the duty and application.

Location of temperature probes:

- a) Separate temperature probes shall be installed at the sleeve and/or rolling bearings of each pump and motor and at the gland housings of the pump to monitor the temperatures at these points.
- b) The probes shall be spring-loaded to ensure positive contact with the bearing shells or gland stuffing boxes.
- c) Each probe shall be clearly identified by means of an engraved marking on the sheath and shall be individually calibrated. Test certificates covering the calibration results of all temperature probes shall be submitted to the Engineer.
- d) Temperature detectors offered, shall be suitable for operation in conjunction with temperature indicating, monitoring, alarm and trip equipment of Conlog or equivalent design.
- e) If grease lubricated bearings are offered, the Tenderer shall indicate if temperature detectors can in fact be used. If temperature detectors are not feasible, the Tenderer shall indicate alternative means of monitoring bearings.
- f) Pockets for standard mercury filled glass thermometers shall be provided adjacent to all pockets serving temperature indicating instruments. Pockets for standard thermometers shall have chained covers to prevent the ingress of dirt when not in use and shall be so arranged as to permit the accurate measurement of the bearing temperature. The pockets shall contain a small amount of oil and shall therefore be orientated within 30° of the vertical, horizontal pockets are not acceptable.
- g) Each pump casing shall be fitted with a thermo switch, Fenwall, or equal approved make to safeguard the pump in the event of inadvertent sustained operation against a closed discharge valve. The thermo switches shall be calibrated to close when the temperature of the water in the pump casing exceeds 40°C.

PT 5.11.3 Pressure gauges

- a) Each pump set shall be equipped with two 150 mm dial diameter flush mounting pressure gauges. The gauges shall be calibrated in kilopascal and the angle shall suit the particular application. The gauge shall be filled with glycerine, and the bubble shall be out of the range of usual reading. The gauges shall be of a type that is possible to recalibrate (dead-weight method) and reset on Site.

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- b) These meters shall indicate water pressure in kilopascal and shall have a range at least 50% higher than the normal duty point. However, in all cases the gauges must have a range at least 30% higher than the shut off, or maximum, head which the pump is capable of generating with the system conditions taking into consideration the maximum static suction pressure possible.
- c) The meters for the suction side of pumps shall be compound gauges and shall be capable of indicating a negative pressure of up to 100 kPa. However, in all cases the gauges must have a range at least 30% higher than the maximum static suction pressure possible.
- d) All pressure gauges shall be supplied and installed complete with isolating Steel cocks, copper or stainless steel piping, etc. and fitted with a pulsation snubber in stainless steel.

Due to the quality of the water, those submitting tenders should satisfy themselves of the reliable operation of the gauges. Where necessary they must include for the pressure gauges to be fitted with diaphragms. Pipes to pressure gauges neatly supported between tapping point and pressure gauge. Pedestals to the Engineer's approval shall be supplied at a suitable position to house the pressure gauges.

PT 5.11.4 *Pump set vibration sensors*

- a) Suitable vibration sensors shall be mounted on each pump set to stop it on detection of excessive vibration. The sensors shall be situated as close as possible to those bearings where the highest vibration levels are encountered.
- b) The monitoring of vibration shall be made via a suitable timing device in order to avoid tripping when starting the pump set or during other transitory conditions.
- c) The pumps shall comply with the requirements of BS4999.

PT 5.11.5 *Automatic air vents*

If an automatic air vent is specified for the pump casing, it shall be fitted with an indicator to show the open and closed positions of the air vent. The air vent shall be suitable for remote operation and the control of the air vent shall be mounted on the control panel inside the pump house.

PT 5.11.6 *Gland leakage detection*

A device to monitor gland leakage shall be supplied and fitted with adjustable alarm contacts designed to close when gland leakage rises to a pre-set value.

PT 5.11.7 *Wear limit switch*

Multistage pumps should be fitted with a wear limit switch to protect the pumps against damage after normal wear of the wearing rings have taken place after a period of operation.

PT 5.12 *Corrosion Protection*

PT 5.12.1 *Internal protection*

Final coat colours to be confirmed by Engineer prior to delivery to Site. Submersible pumps shall preferably be FBE protected.

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All traces of rust, slag, silica or other contaminants shall be removed by mechanical wire brushing. Abrasive blast clean all interior surfaces to SA 2½ (near white) metal finish to the Swedish Standard SIS 05 59 00. The blast profile shall fall within the limits 40 - 60 microns.

A thorough vacuuming of the interior surface shall be carried out to remove all traces of the abrasive grit before application of internal surface finish.

Apply by brush, or airless spray, three coats of an approved two part epoxy coating, or equivalent, to give a dry film thickness of between 50 and 70 microns per coat. The intermediate coat shall be a different colour to the first and final coats. The total minimum dry film thickness for the complete system shall not be less than 150 microns.

PT 5.12.2 **External protection**

All sharp edges, laminations and protrusions shall be removed by mechanical grinding, whereafter all traces of rust, slag, silica or other contaminants shall be removed by mechanical wire brushing. The entire surface shall be degreased using a suitable water emulsifiable degreaser. Surfaces shall be left clean and dry prior to coating.

One coat of zinc phosphate high build primer shall be applied (Plascon Code UC 183 or similar) by airless spray to a dry film thickness of 75 µm, and left 8 hours to dry.

The primer shall be followed by one coat of universal undercoat, (Plascon Code UC 1 or similar) applied by brush, roller or airless spray to a dry film thickness of 30 µm. This coat shall be left to dry for 16 hours.

The final coat shall be one coat of universal gloss enamel, (Plascon Code G or similar) applied by brush, roller or airless spray to a dry film thickness of 25 µm. This shall be left to dry for 20 hours. Colour will be as directed by the Engineer.

PT 5.12.3 **Designation and Information Plates**

Each pump shall be supplied with an information plate - preferably chromium plates - secured to the pump casing in a visible position indelibly marked with the following details :







- Maker's name, pump type and serial number
- Year of manufacture
- Rated duty of pump in litres per second
- Head in metres at rated duty
- Pump speed in revs per minute
- Impeller diameter
- Mass of completely assembled pump in kilogram
- Types and sizes of Bearings
- Letters and figures shall be engraved, or embossed, not stamped

PT 5.13 **Inter-changeability**

Where two or more similar pumpsets are required, the pumps and motors shall be interchangeable in all respects.

PT 5.14 **Operating and Maintenance Manual**

Three copies of the Operating and Maintenance Manual shall be supplied by the Contractor not later than at the time of commissioning of the installation. This manual will be a

					
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prerequisite for commissioning of the plant and a separate manual shall be compiled for each installation.

PT 5.14.1 Contents

The manual shall cover the following aspects in detail, with illustrations and drawings:

- a) Index: Each volume shall have an index following the title page. If there is more than one volume, the first volume shall contain a master index.
- b) A Brief description of the plant and installation.
- c) Pre-commissioning checks: These shall be clear, concise, easy to follow and shall include pre-start checks (e.g. check oil and water, remove locking pin, etc.), safety checks (e.g. personnel cleared from vicinity of water outlets, guards in place, etc.).
- d) Detailed operating instructions: These shall be clear concise, easy to follow and shall include starting procedure, running checks (e.g. no vibration, pressures normal), shut-down procedure, emergency shut-down procedure and action to be taken in response to alarm signals.
- e) Proposed preventative maintenance schedules and programme covering all plant and equipment; the Maintenance chart.
- f) Fault diagnosis and repair procedures: These shall include details of all servicing, replacement and repairs which Artisans or Operating personnel would be expected to carry out on Site. In this section the reader may be referred to suppliers brochures elsewhere in the Manual for specific detail.
- g) Schedule of manufacturing drawings.
- h) Detailed schedule of plant components giving material specifications, part numbers, etc. Where possible, drawings shall be positioned opposite the appropriate text.
- i) Sub-contractor's/Supplier's brochures and instructional literature.
The requirements for the Operation and Maintenance Manual for electric motors are covered elsewhere.
- j) Mothballing procedure.
- k) Schedule of lubricants.

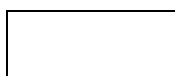
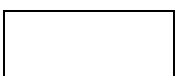
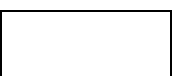
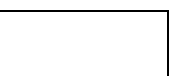
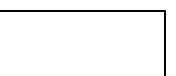
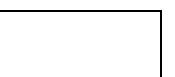
PT 5.14.2 Non availability

Commissioning will not be performed and payments will be deferred if complete. Operating and Maintenance Manuals are not available at the time of commissioning.

PT 5.15 Drawings and Documentation

PT 5.15.1 Drawings

The drawings included in the Tender Documents are the Engineer's proposal for the plant lay-out. Proposed alternatives by the Tenderer indicated on drawings submitted by the Tenderer, shall be considered in allocating the contract. General arrangement drawings must be provided for all equipment.

					
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- PT 5.15.2** Before any work is carried out by the Contractor and within six weeks after date of order, the Contractor shall submit detailed working drawings to be approved by the Engineer. Approval of these drawings does not relieve the Contractor from his responsibility for the correctness of the drawings.
- PT 5.15.3** Fully dimensioned outline and layout drawings of all plant and equipment shall be supplied including ancillary equipment, giving fully particulars as to the sizes and positions of all anchor bolts, bolt holes and other recesses; vents and drains; oil, gland or cooling and service water; anchor blocks, supports, foundations and embedded parts, including all necessary clearances around items of equipment and the lifting requirements and any other information which may effect the construction of the Pump Station structure.
- PT 5.15.4** The magnitude and direction of the thrust forces to be resisted by the foundations or anchor blocks shall be clearly given.
- PT 5.15.5** Detailed dimensioned outline drawings of each electric motor, junction box and control console shall be included, showing the position of each panel, clearance space required and the height of each cable gland above the floor.
- PT 5.15.6** The above-mentioned information shall be binding once it has been approved by the Engineer. All costs due to alterations made after this approval will be invoiced to the Contractor. The Contractor will be required to formally approve the civil and electric cable routing drawings made by others.

PT 6 TOLERANCES

The tolerances as specified in the Project Specification or the appropriate SABS or BS Standards, shall apply.

PT 7 SUBMERSIBLE PUMPS

PT 7.1 Equipment required

The number and position of all submersible pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 7.2 Pump/Motor Unit Design and Construction

The pump and motor shall be fully submersible in up to 40 m deep water and shall be a single unit with no shaft coupling between the pump and motor. The pump unit shall automatically and firmly connect to a special discharge connection. The pump, attached to a chain, shall be guided down from the top of the station by two guide bars to the discharge connection at the bottom of the wet well. There shall be no need for personnel to enter the wet well to secure the pump in position. Sealing of the pump unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact or o-ring type seal situated in the pump discharge flange for ease of replacement. No portion of the pump/motor unit shall require any support directly on the floor.

Pump casing shall be from grey cast iron to BS 1452 Grade 260 with smooth surfaces devoid of blow holes or any other irregularities. The pump volute shall be non concentric in design with smooth passages large enough to pass solids and foreign material as indicated in the Project Specification. All bolts, nuts and washers shall be of 304 Stainless Steel. All external and internal metal surfaces in contact with the pumped liquid excluding Stainless Steel or brass, shall be corrosion protected in the factory by epoxy paint or powder coating as described in the Project Specification or General Corrosion Specification.

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Sealing design of major components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is essential shall be machined for and fitted with O-rings. Fittings will comprise controlled compression O-rings in two planes and O-ring contact of four sides without the requirements of a specific torque limit. Rectangular sectioned gaskets requiring a specific torque or the use of sealing compounds shall not be considered.

PT 7.3 Cooling System

The fully submerged motor shall be adequately cooled by the surrounding liquid without the need for external cooling liquid.

If required in the Project Specification, a water jacket shall encircle the stator housing of the motor, thus providing heat dissipation for the motor in case of the motor not being completely submerged in liquid. Impeller back vanes shall provide the necessary circulation of the liquid through the water jacket. The cooling media channels and ports shall be non clogging by virtue of their dimensions. External cooling and seal flushing shall also be provided. The cooling system shall provide for continuous pump operation in ambient temperatures of up to 40°C.

PT 7.4 Cable Entry Seal

The cable entry seal shall be tight for a depth of up to 40 metres. The cable(s) shall preferably enter the motor terminal chamber through a loose cast iron sleeve which shall be attached to the cable end in the factory. All cavities between the four cores of the cable and the inside of the sleeve shall be completely filled with approved resin. The sleeve shall have at least a single groove for an o-ring machined into its outer surface. This sleeve shall fit into a machined cavity in the motor terminal chamber and a watertight seal shall be provided by the O-ring. The sleeve shall be equipped with a flange and shall be held in place by Stainless Steel bolts with washers.

Alternative cable entry seal systems may be considered. Details of the cable entry seal shall be provided in the tender offer.

PT 7.5 Bearings

The pump/motor shaft shall rotate on two permanently greased bearings. The non locating upper bearing shall be a single row roller bearing. The lower bearing shall be a double-row angular contact locating bearing to compensate for any axial and radial forces.

PT 7.6 Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system between the pump and motor, consisting of two independent seal assemblies. Seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal surfaces at a constant rate. The lower primary seal unit located between the pump housing and the oil chamber, shall contain one stationary and rotating corrosion resistant tungsten carbide ring. The upper unit located between the oil chamber and the motor housing shall contain one stationary and one rotating corrosion resistant tungsten carbide ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment. It shall not depend on direction of rotation for sealing. For special applications other seal face materials shall be available. Each pump shall be provided with an oil chamber for the shaft sealing system. The drain and inspection plug shall be accessible from the outside.

PT 7.7 Pump/Motor Shaft

The pump and motor shaft shall be a single unit. The pump shaft is an extension of the motor shaft and shall be from 304 Stainless Steel or EN54 or better. The shaft shall not be in contact with the pumped liquid.

PT 7.8 Impeller

The impeller shall be of 304 Stainless Steel or better and shall be dynamically balanced. The impeller shall be double shrouded and non-clogging. Impellers shall be capable of handling silt, solids and other matter found in the pumped liquid (see the Project Specification for details). Where possible a full vaned, non-vortex type impeller shall be used for maximum hydraulic efficiency, thus reducing operating cost. The impeller shall be keyed to the shaft, retained with an Allen bolt in the impeller. The inertia of the rotating unit shall be provided.

PT 7.9 Wear Rings

An easily replaceable wear ring system shall be used to provide sealing between the volute and the suction inlet of the impeller. The casing wear ring shall be made of brass and shall be held in position by press fit or Allen screws. The impeller wear ring shall be fitted to the suction inlet of the impeller and shall be made of the same material as the impeller. The ring shall be held in position by heat shrink fit or Allen screws.

PT 7.10 Ancillary requirements

Any/all ancillary requirements and additional mechanical items shall be stated in the Project Specification.

PT 8 AXIAL FLOW PUMPS

PT 8.1 Equipment required

The number and position of all submersible pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 8.2 Impeller

The maximum rotational velocity of the pump impeller shall be submitted with the tender. After assembly of the finished impeller, shaft and mounting flange but before dispatch to Site, the assembled unit shall be dynamically balanced at twice the maximum operating speed of rotation and in addition shall be tested for centricity and correct angular attachment of impeller and flange to shaft, all in the presence of the Engineer or his representative.

PT 8.3 Bearings

All bearings shall be designed for a life of at least 100 000 hours at a B10 rating. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads (imposed by the stirrer) acting simultaneously, and shall be selected such that the following condition is complied with:

$$\frac{\text{actual radial load}}{\text{permissible radial load}} + \frac{\text{actual axial load}}{\text{permissible axial load}} = \text{less than } 1,0$$

(where the 'permissible' loads are the manufacturer's figures for 5 000 hours at a B10 rating). Tenderers shall indicate what these forces are and how they are accommodated.

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Casings shall be made of close grained cast iron and shall be designed such as to prevent moisture from entering.

PT 8.3 Bolts

Holding down bolts and jacking bolts which are to be built into concrete work for securing the plant shall be supplied and installed under this section of the Contract. Grouting up of these bolts will be done by the construction contractor after completion of the setting up of the plant by the Contractor under this Contract.

PT 9 SELF PRIMING CENTRIFUGAL PUMPS

PT 9.1 Equipment required

The number and position of all submersible pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 9.2 General requirements

The pumps shall be of the self priming centrifugal type and shall be horizontally mounted and fitted with a Vee-belt drive assembly. The speed shall not exceed 1 450 rpm.

The casings of the pumps shall be high quality close grained cast iron to BS 1452. Means shall be provided in the casing to gain complete access to the pump interior to permit the clearance of blockages and to provide simple access for service and repairs.

All openings, internal passages and internal recirculation ports shall be large enough to permit the passage of a sphere 75 mm in diameter.

The pump shaft shall be contained within a bearing pedestal of ample size to contain heavy duty ball thrust bearing and radial bearing of adequate size to withstand all imposed loads. The bearing shall be oil lubricated, with the bearing pedestal cooled by pumped liquid.

The pump shaft shall be sealed against leakage by a mechanical seal. The seal faces and seat shall be self-aligning.

An air release system shall be provided to release air from the pump casing at its highest point and the pipe shall discharge into the sump. This is to be made of resistant material to the corrosive atmosphere of sewage.

The pumps shall be mounted on base plates of rigid construction, provided with suitable openings for pouring in grout and all necessary holding down bolts to secure the foundations. Concrete work will be finished to approximately 20 mm below the underside of the base plate and when erecting the pump and motor, the Contractor shall arrange for setting each unit to exact line and level by means of steel wedges. Thereafter the contractor will grout in the holding down bolts and grout the base plate to the satisfaction of the pump supplier.

PT 9.3 Ancillary requirements

Any/all ancillary requirements and additional mechanical items shall be stated in the Project Specification.

PT 10 INSPECTION, TESTS AND COMMISSIONING

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

7 PT - Pumps (General) - June25

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PT 10.1 General

PT 10.1.1 Contractors shall, if requested make available for inspection, their internal Quality System Manual, their Standard Procedure Manual and their Works Instructions. Preference shall be given to Contractors who have been audited and found to satisfy the requirements of the ISO 9000 Quality system.

PT 10.1.2 Inspection and tests required of the Contractor include the tests and inspections in the workshops and the inspections and tests at Site.

PT 10.1.3 Depending on the results of the tests and inspections, penalties may be applied and, in certain cases, part or all of the equipment may be rejected, as set out hereinafter.

The cost of all tests and inspections shall be included in the Tender. For instance, the cost of commissioning and testing at Site shall be stipulated in the Price Schedule under the section provided or included as part of the cost of erection. (Except for the cost of power and water consumed.) No claim for travelling expenses or further time required for testing will be allowed.

PT 10.1.4 Tenders shall fully acquaint themselves with the properties of the water to be pumped. Any wear of portions of the pump or ancillary equipment that will affect its operating efficiency during the Period of Maintenance will result in the pump set being rejected.

PT 10.1.5 Signs of cavitation pitting on pump parts will not be acceptable.

PT 10.1.6 Leakage from any oil, water or air circuit will not be acceptable.

PT 10.1.7 Leakage at the glands shall be controlled to the minimum required and drained to the Pump Station sump.

PT 10.1.8 Operation of pumps shall be free from undue vibrations throughout the full range of normal running conditions. Vibration levels should not exceed the limits determined by VDI 2059 for good vibration behaviour.

PT 10.1.9 In no case shall temperature-rise above the ambient temperature reach or exceed 40°C for any mechanical component. For temperature-rise of bearings see Clause PT 5.7.7.

PT 10.1.10 In the case of routine tests concerning standard equipments or material quality control tests, not attended by the Engineer or his Representative, tests reports or certificates in duplicate shall be submitted to the Engineer.

PT 10.1.11 The Contractor shall notify the Engineer or his Representative in writing two weeks in advance, of the place and dates at which the equipment may be inspected and tested.

PT 10.1.12 The Engineer or his Representative will inform the Contractor of his intention to attend the test or the inspection and propose a date which suits him. If the date preferred by the Engineer is later than ten days after the first possible date, the Contractor shall be entitled to perform the test or inspection without the presence of the Engineer.

PT 10.1.13 If on any agreed date the equipment to be inspected or tested is not ready and the test or inspection has to be postponed the Contractor shall be held responsible for the travelling and/or living expenses of the Engineer and/or his Representative.

PT 10.1.14 When tests and inspection have met the satisfaction of the Engineer or his Representative a certificate of Workshop Acceptance will be issued by the Engineer. The Contractor shall not pack and dispatch to Site any equipment before receiving the relevant "Certificate of Workshop Acceptance."

Contractor

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Witness 2

Employer

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Witness 2

PT 10.1.15 The Engineer's acceptance shall in no way relieve the Contractor of any obligation with regards to the Specification.

PT 10.2 Tests

PT 10.2.1 Performance tests

Each pump complete with its driving unit shall be tested at the Manufacturer's works, or other location approved by the Engineer to "Class B" requirements of BS 5316 Part 2, and the efficiency carefully measured. Variations from the actual running conditions of the pumps are allowed as defined in the standard. Unless otherwise explicitly mentioned, cavitation tests are required at works.

PT 10.2.2 The tests shall be witnessed by the Engineer or his Representative and details of the tests and the results obtained, duly signed by the appointed Witness, shall be submitted to the Engineer before despatch of the pumping units from the Manufacturer's workshop.

PT 10.2.3 The rotating elements of the pumps and motors shall be dynamically balanced before assembly. The residual unbalance should be better than ISO 1940 grade G 6.3. The good balance of the whole pump set will be checked by measuring the absolute vibration on pump and motor bearing housings.

PT 10.2.4 Tests shall be performed with the pump set on sound foundations, similar to those expected at Site.

PT 10.2.5 Measurements shall be taken in the three axes at each bearing, i.e. axial and two radial components at right angles to each other.

PT 10.2.6 Performance and vibration tests as described above are to be performed before installation on Site for all pump sets larger than 22 kW. If these tests are impractical or impossible at the pump manufacturer's works, Tenderers must state this in their Tender and explain the reasons why it is so. The Engineer may be prepared to consider alternative proposals for testing provided these proposals are submitted with the Tender and are clearly described and defined. If this is not done, the Tenderer will arrange to have the tests performed in another workshop at his cost.

PT 10.2.7 All pieces of equipment subject to water, oil or air pressure shall be pressure tested at a pressure not less than one and a half times the design pressure.

PT 10.2.8 Each piece shall withstand the hydrostatic test pressure without exhibiting signs of sweating, undue deformation and stressing, or defect of any kind.

PT 10.2.9 Hydrostatic testing shall be done with blank flanges bolted on the flanges of the piece. The use of tie-bolts or other forms of restraint applied across the blank flanges to restrain the bodies from deflecting under the applied test pressure will not be permitted without the Engineer's approval.

PT 10.2.10 The hydrostatic test pressure shall be maintained for a period of at least 10 minutes.

PT 10.3 Performance Test Results

PT 10.3.1 At Works

Contractor

Witness 1

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Witness 2

- a) The overall percentages of efficiency as calculated from the tests should not be less than the appropriate guaranteed figures at the duty points by more than 3%.
- b) The measured flow rates should not differ from the guaranteed deliveries at any point other than the duty points on the characteristic curves as supplied by the Tenderer by more than 5%.
- c) The NPSH requirement should be met for the specified duty point. Where requested by the Engineer additional tests will be required to demonstrate the pump performance at run out conditions, or where the NPSH available is critical.
- d) Peak to peak vibration displacement shall not be more than 10% higher than the required displacement.
- e) The Contractor will be allowed a period of four weeks to carry out any amendments to the plant which he may consider necessary to meet the guaranteed figures. Any period granted for design amendments shall not extend the Contract Period.
- f) Further tests shall then be carried out at the Contractors expense and if the test results in question are still not within the limits specified, the Engineer shall have the right to:
 - either reject the entire plant and recover all monies already paid to the Contractor,
 - or, let the Contractor continue with the installation of the pump sets which may be subjected to penalties or rejection as defined hereinafter when the performances tests at Site are performed.

PT 10.3.2 **At Site**

At the time of performance tests at Site:

- should the test results obtained for either efficiency, flow rate, NPSH or vibration still vary beyond the limits indicated in clause PT 7.3.1 above, the Contractor will again be allowed a further four weeks to make such amendments as may be considered necessary and if after these amendments have been made the test results in question are still not within the figures which have been guaranteed, the Engineer reserves the right, according to circumstances, to reject the plant entirely.
- any other discrepancies, abnormal wear or malfunctioning of plant which may be observed during the Acceptance Tests shall be corrected by the Contractor without delay.
- the date of completion shall be the date on which the Acceptance Tests at site have been satisfactorily completed and the plant is in a fully operational state in accordance with the Specification.

PT 10.3.3 Any period granted for design amendments shall extend the Period of Maintenance by a corresponding amount.

PT 10.4 Commissioning

(See pro-forma form to be completed, bound in at the back of the Project Specification).

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- a) On completion of mechanical and electrical erection and as soon as water is available and other circumstances permit, the Contractor shall arrange for the commissioning of all units of the pumping plant in the presence of the Engineer. The Contractor shall ensure that his equipment is suitably prepared before giving the Engineer fourteen days notice in writing of the date of commissioning.
- b) Before the commissioning, the Contractor shall satisfy himself and subsequently prove to the Engineer that all items on the following checklist have been checked and are functioning correctly:
 - Visual check of general appearance of plant.
 - Check power supply to motor available.
 - Determine the direction of rotation.
 - a) Remove coupling.
 - b) Correct if necessary.
 - Check if pump is turning freely by hand.
 - Check axial float of pump.
 - Check thermocouple operation/calibration if required.
 - Check if pump requires gland packing (Mech. seal flushing).
 - Check pumps and motors for correct grade and quantity of bearing lubricants (oil/grease packed).
 - Alignment of pump and motor.
 - Suction isolating valve open (bypass open).
 - Control valve/reflux valve closed.
 - Delivery isolating valve open.
 - Check if discharge line is full of water.
 - Bleed off air on pump and pipe works.
 - Cooling water flow to bearings if installed.
 - Check balancing water if required.
 - Monitoring and operating equipment are functioning correctly.
 - Test run of pump.
 - a) Number of recommended start - stop of motor.
 - b) Bearing temperature (motor and pump).
 - c) Pump speed.
 - d) Suction pressure.
 - e) Discharge pressure.
 - f) (Volts) (Amps) (kW).
 - g) Quantity pump is pumping.
 - h) Vibration levels.
 - i) Rundown time of pump and motor.
 - j) Simulate an emergency shut-down of pump.
 - k) Check pump and pipework for water tightness.

NOTE: The Contractor to ascertain from the Pump Manufacturer whether the items on the check list are sufficient for the successful commissioning of the pumpsets.

- c) The pumpsets shall be run without interruptions separately for at least 4 hours or such further time as may be required to reach stable operating conditions (particularly, motor temperatures shall be stable).
- d) If the prescribed duration cannot be achieved, the initial commissioning shall take place at a date to be agreed upon by the Contractor and the Engineer. It is to be borne in mind that the penalties for late delivery shall be linked with the initial commissioning.

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Employer

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- e) After the above commissioning, the plant shall be run under approved supervision for not less than two months before the Acceptance Tests are conducted. The Contractor must satisfy himself that the operators are in a position to operate the plant safely and correctly should he be absent from Site during this period.
- f) Commissioning shall not be considered to be complete until complete O&M manuals have been supplied and the plant is capable of continuous operation by fully trained operators of the Employer and until two months have elapsed and the plant has passed the Acceptance Tests as specified.
- g) The Acceptance Tests shall be performed only if and when every item of the whole Contract is fulfilled and if and when each piece of equipment, including the monitoring and control devices, is working properly. The Engineer is entitled to postpone the Acceptance Tests if any part of the Contract is not to his satisfaction or if the plant has not been successfully operated for at least 200 hours.
- h) The Certificate of Commissioning for the equipment is issued by the Engineer only when the results of the Acceptance Tests, recorded in a report prepared and submitted by the Contractor, are found satisfactory.
- i) Final Operation and Maintenance Manuals shall be made available before the Certificate of Commissioning is issued.
- j) The Defects Liability Period (or Guarantee Period) commences at the date of the Certificate of Commissioning.
- k) During the first 14 days of operation of the scheme, the Contractor shall be on site to rectify any problems with the scheme within 24 hours of being telephonically notified. During the remainder of the maintenance period, the Contractor shall within 14 days of being notified, commence rectifying any possible problems that the Employer may encounter with the equipment supplied under this Contract.
- l) Should the Contractor fail to meet the above requirements, the Employer may appoint others to undertake the necessary repair work at the Contractor's cost.
- m) After the satisfactory conclusion of the Acceptance Tests on Site and the issue of the Certificate of Commissioning, the Contractor shall guarantee the satisfactory operation and functioning of the entire plant covered by the Certificate of Commissioning for a period of twelve months measured from the date of the Certificate of Commissioning.
- n) The Contractor shall make good, free of all charges, any defects arising during this Period of Maintenance including the replacement of all defective parts and their installation and recommissioning. This guarantee shall apply to all defects arising during proper use of the plant, due to faulty design or maintenance instructions, inferior materials or poor workmanship.
- o) Maintenance by the client's personnel during the Defect Liability Period shall be limited to cleaning and lubrication only as instructed by the Contractor. All other maintenance or adjustments shall be carried out by the Contractor.
- p) The Final Certificate will be issued by the Engineer when the Defects Liability Period has elapsed and all Contractual obligations have been met in accordance with the General Conditions of Contract.

PT 11 INSTALLATION OF PUMP SETS

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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PT 11.1 Couplings

All pumps are to be matched for coupling to their respective motors. Couplings shall impose no restriction on normal end play or expansion and shall be provided with a removable guard, painted red. The direction of rotation shall be indicated with a clear arrow painted on the exterior of the coupling guard. The latter shall be designed thus to render reversed mounting impossible.

PT 11.2 Grouting of Base-Plates

Base-plates shall only be grouted after the alignment of pump sets has been approved. The Contractor must provide details of the grouting procedure he intends to utilise. Grouting of base-plates shall be done by the Contractor and he shall ensure full grout penetration between each pump base and relevant base-plate.

PT 11.3 Pump Set Alignment

PT 11.3.1 General

It is accepted that all new pump sets have been aligned on the base-plates in the factory. A certain amount of base-plate deformation is possible during transit and installation. Therefore, the alignment shall be rechecked on site following a hot run as specified hereafter.

Two main checks are to be carried out, viz.

- a) angular alignment and
- b) radial alignment of the pump shaft

The checks are to be done on all pump sets.

PT 11.3.2 Preparation

Before any check, the following preparations shall be performed:







- Final grouting to the base-plate shall be completed.
- Driving unit shall be isolated from the power supply. The Contractor shall ensure that no damage can be caused by turning either unit (driving or driven unit).

Couplings should be fixed to their respective shafts and the segments must be free to move relative to each other. Where the method of coupling is too tight to allow free movement between the two half-couplings the rims should be marked so that readings can be taken when the two marks are in line.

PT 11.3.3 Alignment Checks (See attached Data Sheet)

*Angular Alignment
(See Fig 1)*

- i) Clamp two clock gauges diametrically opposite coupling pin holes of the driving or driven half-coupling, the plunger ends resting on the back of the opposite half-coupling.
- ii) With one gauge at the top and one at the bottom set both gauges to zero.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- iii) Turn both couplings through 180°. If the alignment is correct, the readings on the gauges should be numerically the same, although not necessarily zero.
- iv) Adjustment should generally be made on the outboard end of the pump.
- v) Turn both couplings through 90° and set the clock gauges to zero. Repeat step iii).

Note: This method does not require axial location of either half coupling.

Intersection of Axis (Radial Alignment)
(See Fig 2)

- i) Clamp one clock gauge into one of the coupling holes in the driving or driven half-coupling, the plunger end of the clock gauge seating on the rim of the other coupling.
- ii) Rotate the couplings together and note the readings at each quarter turn.
- iii) Adjust the position and heights of the units until uniform clock readings are obtained.

Note: Where the operating temperature of a unit has the effect of lifting the centre line of one machine in relation to the other, allowance in the height of the appropriate machine must be made. Height adjustment must be in accordance with the manufacturer's specifications.

PT 11.3.4 Tolerances

- i) **Angular Alignment:** The angle between two half-couplings shall not be more than 0,01° for speeds up to 1500 rpm. This corresponds to a variation of 0,05 mm and 0,02 mm between readings on a 300 mm diameter coupling.
- ii) **Radial Alignment:** If readings vary by more than 0,10 mm (i.e. 0,05 mm eccentricity) for 1500 rpm adjustments shall be made.

PT 11.3.5 Grouting of Base-Plates

- i) A gap of approximately 25 mm is provided between the base-plate and top of the foundation.
- ii) Following approval of initial pump set and pipework alignment, the Contractor shall erect suitable formwork along the base-plate perimeter and shall grout the entire aforesaid gap, foundation bolt pockets and base-plate volume up to the top surface of the base-plate. appropriate grout holes shall be provided on the base-plate surface for this purpose. The Contractor shall timeously, prior to erection, submit to the Engineer full details of the grout type required, which should attain a design compressive strength of 30 MPa within 10 days.
- iii) Prior to execution of final shaft alignment checks, the grouting operation shall have been completed, the grout adequately cured and all foundation bolts tightened.
- iv) Final alignment control checks to be performed in the presence of the Engineer (or his appointed representative), immediately following a hot run.
- v) Alignment Control Sheets will be completed for every unit checked, and will be signed by both the Engineer and the Contractor. The original copy will be kept by the Engineer and a duplicate by the Contractor.
- vi) For alignment control sheet, see annexures to specifications.

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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PT 11.3.6 *Installation of Dowel Pins*

Following approved alignment of pump sets, suitable dowel pins shall be fitted to facilitate correct re-location of pump sets.

PT 11.3.7 *Manufacturer's Certificate of Approval*

Following wet commissioning of pump sets, the pump manufacturer or his approved supplier shall check the installation and when satisfied shall issue to the Engineer a certificate approving installation in compliance with the manufacturer's specifications.

The Contractor shall furthermore, upon commissioning, perform vibration tests in the horizontal and vertical planes of each and every bearing housing. The results are to be endorsed by the pump and motor manufacturers for acceptability and handed to the Engineer within 14 days from the commencement of the Defects Liability Period.

It is further required of the Contractor to perform same measurements upon each and every maintenance visit during the Defects Liability Period. The results shall be logged and shall be endorsed by the pump and motor manufacturers for acceptability and handed to the Engineer within 7 days after each maintenance site visit.

PT 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PT 12.1 Design, Drawings and General

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

PT 12.1.1	Provide design drawings and design information as specified.	Sum
------------------	--------------------------------------------------------------	-----

PT 12.1.2	Provide operating and maintenance manuals and "as built" drawings as specified.	Sum
------------------	---------------------------------------------------------------------------------	-----

PT 12.2 Supply and Delivery to Site

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

PT 12.2.1	Pump and motor set complete with pump, motor, couplings, foundation steelwork and baseplate as specified.	No
------------------	-----------------------------------------------------------------------------------------------------------	----

PT 12.2.2	Ancillary equipment associated with pump installation as specified	Sum
------------------	--------------------------------------------------------------------	-----

PT 12.3 Installation Work

<i>Pay Item</i>	<i>Unit</i>
------------------------	--------------------

PT 12.3.1	Pump and motor set complete on base plate	No
------------------	-------------------------------------------	----

The item shall include taking delivery of materials on site, handling safeguarding, installing, painting, grouting and aligning

PT 12.3.2	Ancillary equipment associated with pump installation as specified	Sum
------------------	--------------------------------------------------------------------	-----

PT 12.4 Commissioning

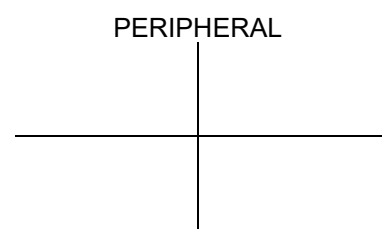
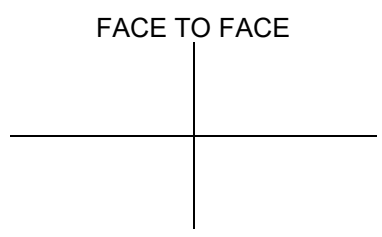
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



	<i>Pay Item</i>	<i>Unit</i>
PT 12.4.1	Testing and commissioning of pumps and appertaining pipework.	Sum
PT 12.5	Provision of additional spare equipment	
	<i>Pay Item</i>	<i>Unit</i>
PT 12.5.1	Supply and delivery of specified equipment to the store facility of the Employer	Sum

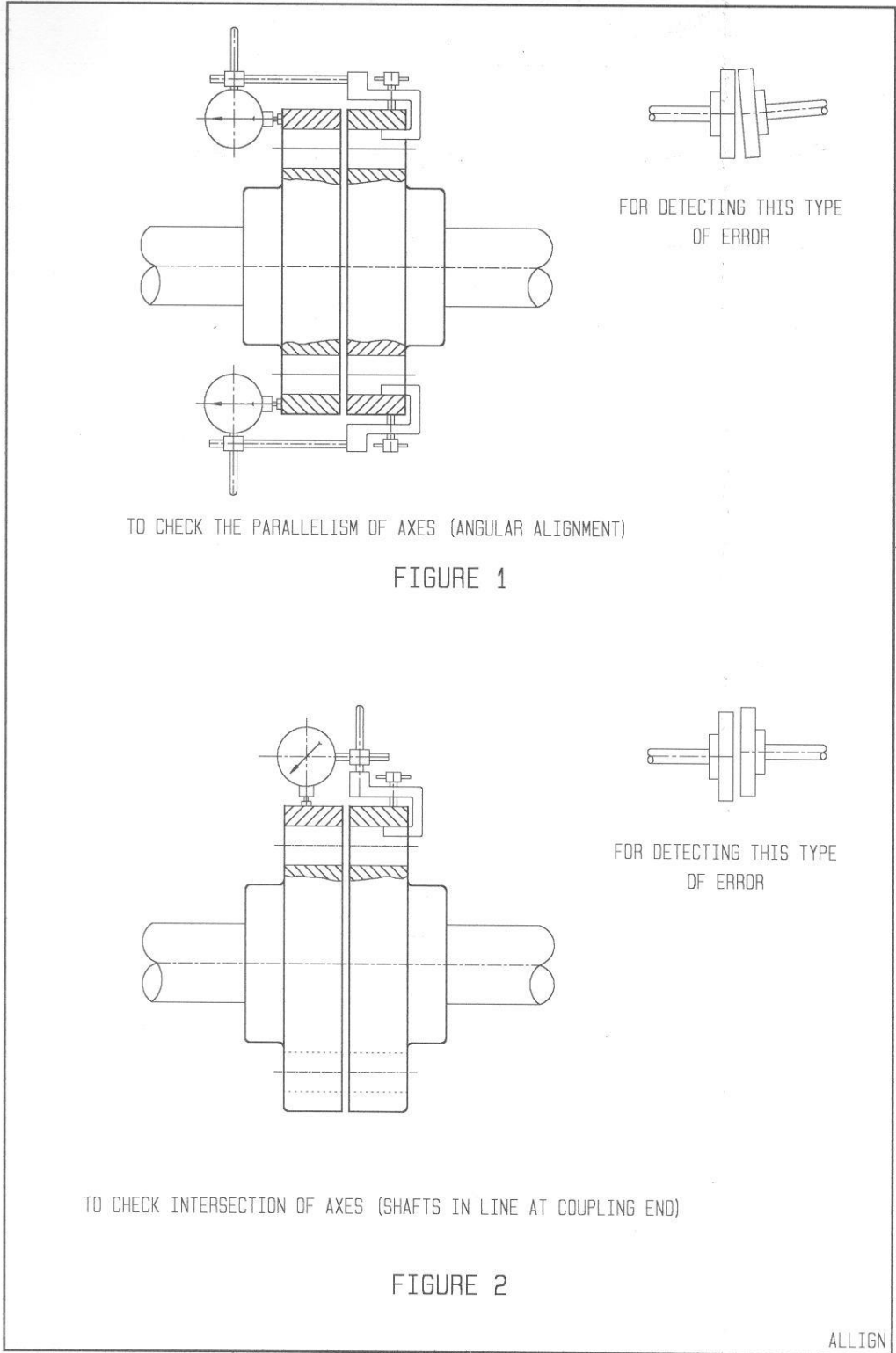
ALIGNMENT CONTROL SHEET

CLIENT:
CONTRACT NO:
STATION: MACHINE TYPE:
UNIT NO: REF NO:
ALIGNMENT BETWEEN:



METHOD OF ALIGNMENT: Dial indicator
READINGS GIVEN IN: mm
ALIGNMENT OF GEAR FITTED TO:
MEASUREMENTS TAKEN ON:
WHICH SHAFT ROTATED:
VIEWED FROM:
DISTANCE BETWEEN SHAFT ENDS:
WHEN SHAFT IN WHICH AXIAL POSITION:
REMARKS: Suction / Delivery pipes connected.
All foundation bolts tightened / loose.
Final grouting done / not done.
.....
.....

Date: Time:.....
.....
CONTRACTOR ENGINEER



Contractor

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Witness 1

Witness 2

Witness 2

Employer

Witness 1

Witness 2

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P R O F O R M A COMMISSIONING									
No	Remarks	Pump Speed	Power	Press ure Suctio n	Press ure Dis- charg e	Temperatures (□C)			
						Pump		Motor	
		R.P.M.	Amps	[kPa]	[kPa]	D.E.B.	N.D.E. S.	D.E.B.	N.D.E. B
CONTRACT NO. :			DESCRIPTION OF CONTRACT:						
DATE OF COMMISSIONING :									
COMMISSIONED BY :			PUMP MANUFACTURER :						
WITNESSED BY :			PUMP MODEL :						

END OF SECTION

Contractor

7 PT - Pumps (General) - June25

Witness 1

Witness 2

Employer

Witness 1

Witness 2

June 2025

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTU: CHLORINE DOSING EQUIPMENT

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PTU CHLORINE DOSING EQUIPMENT

PTU 1 SCOPE

This section of the Specification includes the supply, delivery, installation, commissioning and upholding during the Defects Notification Period of chlorination equipment.

PTU 2 MATERIALS

The chlorinator equipment, all associated chlorine dosing pipework and accessories that may come in contact with chlorine gas or solution shall be constructed of materials resistant to corrosion from the effects of chlorine.

PTU 3 EQUIPMENT REQUIRED

A vacuum operated chlorinator system containing two vacuum regulators suitable for fitting onto 1 ton containers are required. The chlorinator system shall operate in the change-over configuration.

Each vacuum regulator shall have an integral electrical heating system. The vacuum shall be created by an ejector in the chlorine dosing system. The ejector will be driven by a clear or process water supply as specified in the Project Specification. The pressure required in the water supply system to the ejector shall be stated in the tender. Each chlorinator shall be provided with the necessary drainage and ventilation pipes.

Chlorinators shall be adjusted manually by the plant Operator to achieve a prescribed dosage. Flow/residual pacing or automatic rate controlled chlorination shall not be required, unless stated in the Project Specification.

Each system to be supplied and installed under this portion of the Contract must include the following:

- regulators, heaters, rate valves, rotameters, ejectors, in-line strainers, etc.
- for automatic rate control system (if specified): regulators, heaters, actuated gas controller with automatic proportional to flow/residual control facility, appropriate Signal Conditioning Unit (SCU), rotameters, ejectors, in-line strainers etc. The facility to operate the system manually shall be provided.
- the complete gas piping including valves and fittings to the ejectors and the uPVC piping to the diffuser.
- the diffuser shall be designed to match the equipment accepted and shall be readily removable.
- complete piping from the clear/process water supply pipework including valves, fittings and an appropriate pressure gauge to the chlorine room.

The following ancillary equipment will be required:

- The complete electrical installation, cables, etc.
- Electrically driven extractor fan(s) with a capacity of 1 000 l/min.
- A sturdy weatherproof cupboard, 750 x 750 x 300 deep with a 50 mm minimum roof overhang and with two glass doors in front must be mounted on the wall just outside the chlorine room. A hardwood-framed fibre glass covered construction is required. The Tenderer to submit details of his offer with his tender. This cupboard will be used

Contractor

8 PTU - Chlorine Dosing Equipment - June25

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Employer

Witness 1

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to house a resuscitator and two gas masks, completely self contained with oxygen cylinders, etc. "Siebe Gorman" ref. 01457708 or equal. Design of the cupboard must be approved by the Engineer before manufacturing.

- One chlorine detector with alarm unit.
- One lifting beam with hooks suitable to lift the containers with a 2 ton chain block and trolley.
- Emergency repair kit for the containers.
- The change-over device between the containers shall be provided with a potential-free contact for monitoring purposes.
- Emergency shut-off system for containers (refer to PTU 5)

PTU 4 LOAD CELLS

To determine the chlorine available in a container, load cells with a capacity from 0 to 2 000 kg with associated LCD display unit shall be provided. The LCD display unit shall be mounted in the chlorine dosing room. The accuracy of the load cells shall be within 0,25% of scale deflection.

The tare weight of the container must be back balanced to give a net reading of the weight of liquid chlorine available in the container. The platform of the scale must have four trunnions mounted thereon for easy positioning of the chlorine containers. The scale must be sturdy and dependable and of high quality, suitable to operate under extreme condition of dust, moisture, corrosion and impact. The gross weight of a chlorine container is approximately 1 600 kg.

PTU 5 EMERGENCY SHUT-OFF SYSTEM

An emergency shut-off mechanism of the outlet valve of the active containers shall be provided under this portion of the Contract. The system shall operate either electrically or pneumatically. In the case of pneumatic operation, compressor(s) and air storage vessel shall be provided.

The shut-off system shall be activated by a high chlorine level (typically 5 ppm) detected in the chlorine storage area. Once the detection level remains for say 30 seconds, a signal shall be generated initiating the closure of the outlet valves. If the mechanism is operated electrically, the valves shall be closed in the event of a power failure.

PTU 6 MEASUREMENT AND PAYMENT

The tendered prices shall include for the supply, delivery, installation, testing and commissioning of the equipment required as specified:

<i>Pay item</i>	<i>Unit</i>
------------------------	--------------------

PTU 6.1 Chlorine dosing equipment

Chlorinators as specified shall be supplied complete with ejectors, multiple flow meter assembly, rate control valves, isolating and solenoid valves, rotameters, in-line strainers, pressure gauges, by-pass connection, heaters, vacuum regulators and automatic change-over devices (automatic rate control devices if specified)

Sum

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
8 PTU - Chlorine Dosing Equipment - June25			June 2025		

PTU 6.2	<u>Load cells</u>	
	Load cells for weighing 1 600 kg chlorine containers complete with trunnions and LCD displays in dosing room	No.
PTU 6.3	<u>Pipework</u>	
PTU 6.3.1	Cadmium plated copper flexible connectors and seamless steel header piping to BS 1485 from the containers to the regulators including brass plug valves and suitably sized catch pots	Sum
PTU 6.3.2	The complete uPVC piping with the necessary isolating valves, bends, flanges, etc. from the ejectors to the diffuser	Sum
PTU 6.3.3	The complete uPVC piping with the necessary isolating valves, bends, flanges, pressure gauge etc. from the site water installation to the ejectors	Sum
PTU 6.4	<u>Chlorine diffuser</u>	
PTU 6.4.1	Chlorine diffuser complete with the necessary fixing brackets, bends flanges, etc. to complete the installation	Sum
PTU 6.5	<u>Low level fans</u>	
PTU 6.5.1	Low level extractor fans with vent pipes for controlled release	No
PTU 6.6	<u>Ancillary items</u>	
PTU 6.6.1	Wall mounted cupboard with glass front complete with resuscitator and two gas masks	Sum
PTU 6.6.2	Chlorine detector	Sum
PTU 6.6.3	Lifting beam with hooks and 2 ton chain hoist & trolley	Sum
PTU 6.6.4	Emergency repair kit for the containers	Sum
PTU 6.6.5	Emergency shut-off system	Sum

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PLC : CHEMICAL DOSING EQUIPMENT

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PLC CHEMICAL DOSING EQUIPMENT

PLC 1 SCOPE

This specification covers the supply, delivery, installation, commissioning and maintenance for a 12 month period of chemical dosing equipment, associated pumps, pipework, valves and other ancillary equipment for the treatment of water for potable purposes.

PLC 2 INTERPRETATIONS

PLC 2.1 Application

This specification contains clauses that are generally applicable to the supply, delivery, installation, commissioning and maintenance of chemical solution make-up tanks, chemical dosing equipment, associated pumps, pipework, valves and other ancillary equipment for the treatment of potable water.

PLC 3 MATERIALS AND EQUIPMENT

PLC 3.1 Selection Against Corrosion

In a water treatment plant the very corrosive nature of the environment and the substances in contact with the materials and equipment requires that special attention shall be given to the selection of materials and equipment capable of withstanding corrosion due to these circumstances.

Any material or equipment showing signs of corrosion during the Maintenance Period shall be rejected and be replaced by the Contractor at his own expense with materials or equipment resistant to corrosion as shown by a re-test.

PLC 3.3 Information and Technical Data at Tendering

Full information and technical data on all materials and equipment offered, shall be supplied at tendering. Manufacturer's pamphlets and catalogues shall be edited and clearly marked so as to describe the particular equipment offered.

PLC 4 LIME DOSING EQUIPMENT

Provision shall be made for lime dosing at the following points:

- (a) Before the addition of the primary coagulant (pre-liming).
- (b) After filtration (post liming), by saturated lime solution only will be done.

Similar dry lime feeders complete with hoppers, bag loaders and slurry suspension tanks shall be provided for pre- and post liming respectively. To obviate the necessity for a standby feeder, the following are required:

- (a) The maximum dosing rate of each feeder shall be at least 50 percent higher than the sum of the maximum lime demands for pre- and post liming.
- (b) The piping at the slurry suspension tanks shall be arranged as such that each feeder is able to do pre- and post liming simultaneously.

The location of the lime dosing points will be indicated on the drawings.

The maximum dosing rate for pre-liming shall be determined by the lime demand of the raw water at design flow of the plant to achieve the required pH-value for good flocculation as indicated by extensive jar tests.

The maximum dosing rate for post liming shall be determined by the lime demand of the filtered water at design flow of the plant to achieve a stabilised water.

PLC 4.1 Dry Lime Feeders

Each lime feeder for pockets shall be fitted with a hopper directly onto the dry lime feeder which feeds lime at a set rate into a slurry suspension tank.

Each dry lime feeder shall be capable of feeding air separated hydrated lime at a preselected rate. An accuracy of $\pm 5\%$ of the set feed rate is required.

The lime feeder shall feed the lime uniformly and continuously at the preset rate and shall not be of the interrupted cycle type. A feed ratio of 20:1 shall be achievable.

The electric motor of the feeder shall be of the variable speed type, 380 V.

PLC 4.2 Hopper for Lime Feeders

Lime will be stored in 20 kg pockets and will be introduced manually into the hoppers of the lime feeders or from a lime silo as specified.

For bags each lime feeder shall alternately be fitted with a hopper. The minimum capacity of the hopper shall be 4 hours at the maximum dosing rate. The hopper shall be fitted with a removable screen and cover. To prevent the emission of dust during the dosing operation, the hopper shall be fitted with a bag loader with a loading door with rubber seals.

The hoppers and bag loaders shall be manufactured from 2 mm minimum thickness mild steel plate; hot-dipped galvanised to SABS 763 after manufacture; and painted externally with two coats of an enamel paint complying to a colour coding system as determined by the Engineer. Paint to be applied only after suitable surface preparation as required by the paint manufacturer.

A vibrator or other positive acting mechanism shall be provided to prevent the lime from bridging in the hopper or the lime silo.

PLC 4.3 Lime Slurry Suspension Tanks

The circular slurry suspension tank shall be manufactured from a suitable grade stainless steel.

The make-up water introduced shall be maintained at a constant level by means of an overflow top outlet. The tank shall have two (2) top outlets (1 x pre-liming, 1 x post-liming) and a 32 mm diameter drainage outlet at the bottom of the tank. All lime slurry suspension piping shall be minimum 30 mm NB uPVC (Class 16).

To keep the lime in suspension, an electrically driven stirrer unit shall be fitted to the suspension tank. The impeller shall be at the centre of the tank and not more than 100 mm from the tank bottom. If alternative arrangements are offered, the main offer shall be as specified, and full details shall be given of the alternative proposal.

To prevent floating lumps of dry lime from leaving the tank, the tank outlets shall be protected with baffles.

The suitably sized motor of the stirrer shall be a 220 V, dust- and waterproof unit. All cabling between the wall socket and feeder shall be in plastic conduits.
The shaft and propeller of the stirrer shall be stainless steel.

Each suspension tank shall be connected to the service water supply.

PLC 4.4 Lime Saturator

Lime water is used to correct the pH of the filtered water. The water should be saturated with lime and not contribute to a lime slurry build up at the dosing point (have a minimum of suspended lime particles).

Lime water is prepared by feeding a suspension of lime in water (milk of lime) into a tank continuously. The milk of lime is injected by gravity into a sludge stilling pipe in the middle of a round tank with conical shaped bottom. The stilling pipe causes the milk of lime to flow vertically downwards into the tank.

Fresh water is fed into the bottom of the cone at a continuous rate causing an upflow into the tank. The top water level in the lime saturator is determined by an overflow V-notched weir plate.

The fresh water stream causes a counter current flow with the downward feed of milk of lime, causing a slight agitation and dilution effluent which enhances the solution of lime, and allow the undissolved fraction to settle in the cone. Full details of the lime saturator tank are given on the drawings.

PLC 4.5 Bulk Lime Storage Silo

The storage silo(s) will be charged by road tankers with air-hydrated lime. The silo must be elevated to the levels shown on the drawings to allow for gravity dosing of the lime in slurry form into the raw water at the inlet structure.

The silo shall be complete with the following:

- insertable reverse pulse filter mounted in an all welded construction housing.
- a high level switch mounting nozzle in the silo roof, 40 NB.
- approved high level sensor.
- a silo over pressure protection device.
- a 500 diameter inspection manhole.
- handrailing and kick plate all around the silo top.
- an access ladder with backguard leading from the platform to the silo top.
- a 100 diameter filling pipe with tangential material inlet, a flexible joint and “Storz” quick lock couplings.
- a limit switch mounting bracket including proximity switch fitted to the filling pipe for filter interlock purpose.
- a weigh system consisting of three 20 t load cells, a junction box and a weight transmitter.
- a 300 mm diameter rubber – lined discharge valve, hand lever controlled.
- Support structure to elevations as shown, fabricated from hot rolled mild steel sections in welded construction designed to support the above described silo including platform steelwork for access to the dosing equipment. A staircase must be provided leading from ground level to the platform area. All the necessary grating, stair treads and handrailing has to be included too.

PLC 5 COAGULANT DOSING EQUIPMENT

The coagulant solution will be transferred from the coagulant storage tank or tanks directly to the day tank or make-up tanks. The coagulant solution will be pumped undiluted or will be diluted to a specific solution strength, to the coagulant dosing point. Thus for these two options, for any coagulant, a dosing train shall consist of the following:

- (a) Coagulant holding tank or tanks. (Main storage).
- (b) make-up tanks.
- (c) dosing pumps.
- (d) mechanical stirrers fitted above the make-up tanks or air agitation as called for in the project specification.

PLC 5.1 Dosing Pumps

The dosing pumps shall be self-priming, manufactured from plastic or similar material capable of handling highly corrosive chemicals e.g. ferric chloride or similar.

- (a) The pumps shall have in-line removable strainers provided on the suction side, a loading and pressure relief valve as well as an isolating valve on the delivery side.
- (b) It shall have suitably sized motors 380 V, single phase dust and waterproof unit. All cabling between the motor and wall socket shall be in plastic conduits.
- (c) The pump and motor shall be properly aligned and mounted on a 50 mm high plastic or better common baseplate or mounting framework of rigid design.
- (d) The pumping head shall be determined by the Contractor.
- (e) For the option to use either pumps on either make-up tank the piping between the standby main pump and the standby pumps shall be arranged as such that the solution in the make-up tank connected to the standby pump can be transferred through the delivery piping of any of the other transfer pumps by the switching of the necessary valves.
- (f) A measuring cylinder plus isolating valve shall be fitted to the common suction line for pump calibration.

PLC 5.2 Storage Tanks

The requirements regarding coagulant storage tanks are as follows:

- (a) Piping between the storage tanks for a particular coagulant shall be arranged such that any tank can be filled by the switching of the necessary valves.
- (b) The tanks shall hold the required volume specified, manufactured from a suitable plastic or similar material as specified in the Project Specification.
- (c) Two (2) bottom outlets are required. One (1) to supply the chemical to the make-up tank and one (1) to drainage. The drainage outlet shall be as close as possible to the bottom of the tank. The outlet to the doser shall be ± 50 mm above the bottom of the tank.
- (d) The piping from the storage tanks supplying a particular make-up tank shall also be arranged such that any tank can supply the make-up tank.

- (e) Storage tanks shall be positioned such that the full volume above the outlet is available to gravitate to the make-up tanks.
- (f) Storage tanks shall be installed with a bend wall of suitable size contain the entire volume of the tank plus 10%. The bended area shall be supplied with a lockable drain valve.

PLC 5.3 Make-up Tanks

The requirements regarding coagulant make-up tanks are as follows:

- (a) These tanks shall be of the nominal capacity and material as specified.
- (b) Each make-up tank shall be equipped with an electrically driven stirrer unit or air agitation as specified. The shaft and propeller of the stirrer shall be of an appropriate material for the coagulant specified.
- (c) The suitably sized motor of the stirrer shall be 380 V, single phase dust and waterproof unit. All cabling between the stirrer and wall socket shall be in plastic conduits.
- (d) The switch controlling each stirrer shall be equipped with a suitable device (i.e. a float switch or similar) to prevent the stirrer being inadvertently started when the tank is empty.
- (e) The stirrer shall be fixed to a support straddling the make-up tank and properly anchored to the floor, or wall.
- (f) Two (2) bottom outlets are required. One (1) to supply to the dosing pump and one (1) to drainage. The drainage outlet shall be as close as possible to the bottom of the tank. The outlet to the dosing pump shall be ± 50 mm above the bottom of the tank.
- (g) Each make-up tank shall be connected to the service water supply.
- (h) All piping to and from the tanks shall be equipped with isolating valves.

PLC 5.4 Chemical Dosing Pipework, Valves, Fittings

All the required inlet and outlet pipes, valves, specials, jointing and fixing materials, and any additional fittings or equipment required to complete the chemical dosing installation to the Engineers' approval shall form part of this Contract. The Contractor shall submit final design drawings to the Engineer for approval prior to procurement or installation.

All pipes shall be clearly marked for identification purposes and the method of marking will be to the Engineers' approval.

The pipes will run in ducts, pipe supports or trenches as indicated on the drawings. The lime and PAC pipes will be 50 mm dia flexible rubber hoses, adequately supported.

PLC 6 MEASUREMENT AND PAYMENT

- (a) Dosing pumps will be measured per unit.
- (b) Pipework for each chemical will be measured complete as a lump sum including all valves, fittings, fixing, jointing as specified up to the dosing points.
- (c) Storage tanks and day tanks will be measured per unit.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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- (d) Lime feeders will be measured complete per unit including electrical connections.
- (e) Hoppers for lime feeders will be measured complete per unit.
- (f) Lime slurry suspension tanks will be measured per unit complete including agitator and electrical connection.
- (g) Lime saturators will be measured complete per unit.
- (h) Bulk lime silos will be measured per unit complete.

PLC 6.1 Design, Drawings and General

<i>Pay Item</i>	<i>Unit</i>
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PLC 6.1.1	Provide design drawings and design information as specified.	Sum
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PLC 6.1.2	Provide operating and maintenance manuals and “as built” drawings as specified.	Sum
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PLC 6.2 Supply and Delivery to Site

<i>Pay Item</i>	<i>Unit</i>
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PLC 6.2.1	Pump and motor set complete with pump, motor, couplings, foundation steelwork and baseplate as specified.	No
------------------	-----------------------------------------------------------------------------------------------------------	----

PLC 6.2.2	Ancillary equipment associated with pump installation as specified	Sum
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PLC 6.3 Installation Work

<i>Pay Item</i>	<i>Unit</i>
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PLC 6.3.1	Pump and motor set complete on base plate	No
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The item shall include taking delivery of materials on site, handling safeguarding, installing, painting, grouting and aligning

PLC 6.3.2	Ancillary equipment associated with pump installation as specified	Sum
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PLC 6.4 Commissioning

<i>Pay Item</i>	<i>Unit</i>
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PLC 6.4.1	Testing and commissioning of pumps and appertaining pipework.	Sum
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PLC 6.5 Provision of additional spare equipment

<i>Pay Item</i>	<i>Unit</i>
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PLC 6.5.1	Supply and delivery of specified equipment to the store facility of the Employer	Sum
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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTN : SLUDGE DEWATERING EQUIPMENT

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PTN SLUDGE DEWATERING EQUIPMENT

PTN 1 LINEAR SCREEN AND FILTER BELT PRESS

PTN 1.1 Scope

This section covers the following:

- (a) Linear screen type sludge thickener
- (b) Filter belt press
- (c) All connections and accessories required for the proper operation of the plant
- (d) Support structures and access

PTN 1.2 Linear Screen Equipment

The sludge thickener shall be of the linear screen gravity drainage type, using a continuous belt.

A feed chute shall be provided to distribute sludge evenly from the flocculation chamber over the width of the screen belt. Redistribution of sludge to provide efficient drainage shall be accommodated using a proprietary plough system. A further feed chute shall be provided to evenly distribute the thickened sludge onto the filter belt press.

Separate pans shall be provided for the collection of filtrate and wash water from the filter belt which shall be piped away separately.

The inlet and flocculation chamber, feed chute, filtrate and wash water pan, discharge chute and associated equipment in contract with sludge and filtrate and wash water shall be of rigid construction manufactured from grade 304L stainless steel of thickness not less than 2,0 mm.

The filter belt spray wash system, pipework, nozzles and valves shall be manufactured from grade 304L stainless steel. The spray system and nozzles shall be fitted with a manual brush cleaning system of the "STAMM" or equal type.

The screen cloth shall be manufactured from high permeability plain weave durable monofilament polyester fibre selected to meet the duty requirements with an operation life before refurbishment of not less than 5 000 hours.

The aperture size shall be selected to meet the specified performance.

The cloth shall be jointed by an approved clipper seam using high tensile stainless steel cable bonded with resin and incorporating a chevron or similar stabilising seam.

Spillage of sludge over the sides of the belt shall be avoided either by the provision of side skirting or by the dishing of the cloth surface in the drainage zone.

An automatic belt tracking system shall be provided to control alignment under all operational conditions. A proximity switch shall be provided which shall automatically switch off the linear screen in the event of the belt not being maintained on track i.e. belt out of alignment. The switch shall be used to initiate an alarm in the control panel and the feed to the unit shall switch off.

A cloth tensioning system shall be provided which shall include provision for adjustment to accommodate reduced length refurbishment belts.

Where hydraulic belt tracking or tensioning systems are employed a hydraulic power pack with pump reservoir pipework and all necessary equipment to provide a complete operational system shall be provided.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The drive roller shall be manufactured from carbon steel hollow bar and be provided with shafts to BS 4360 Class EN8 or equivalent material. A layer of reinforced rubber of thickness not less than 5 mm or similar material shall be applied to the roller surface and be machined to provide a true face after manufacture.

Other rollers shall be manufactured from standard schedule 40 seamless piping or equivalent material machined after manufacture with shafting and be coated with “Rilsan” or equal thermoplastic polymer material of thickness not less than 1 mm up to the bearing housing.

All bearings shall be of the adjustable roller or ball self-aligning type sealed type adequately rated and suitable for the environment in which they will operate including high pressure washing. A bearing cover and seal shall be provided to give further protection. Lubrication shall be from a common readily accessible location. All grease piping shall be grade 304L stainless steel or equal approved robust material.

The drive arrangement shall be of the mechanical variable speed gear reducer type utilising adjustable pulleys and wide toothed transmission. Rating shall be not less than 1,75 on installed motor power or 2,0 on absorbed power whichever is the greater. All bearings shall be selected for an L10 life of 100 000 hours.

The drain from the gearbox shall be accessible to the maintenance staff.
The Contractor shall ensure that adequate mixing of polyelectrolyte solution and flocculation of the sludge occurs prior to discharge onto the linear screen.

Only in-line or plug flow mixers may be used for mixing of polyelectrolyte and flocculation to achieve a well flocculated feed onto the belt and to meet the performance and duty requirements.

Air sparge bubble type mixers or back mixers are not accepted.

See also PTN 1.4.3.

The unit shall be provided with a solid, impermeable containment enclosure on the four vertical sides. Access hatches shall be provided at all points where access is required during normal operation to observe machine operation, for wash down purposes and for maintenance.

PTN 1.3 Filter Belt Press Equipment

PTN 1.3.1 Frame Construction and Design

- (a) The structural frame of the belt press shall be designed as a single weldment or monocoque design to provide maximum rigidity. It shall be constructed of welded stainless steel members and shall be so designed that rollers can be removed from the side or end of the frame with minimum disturbance to other roller assemblies. Full and complete enclosure shall be provided to prevent egress of spray or spillage and against accidental contact with rolling assemblies during operation.

Access hatches shall be provided at all points on the belt press where access is required during normal operation to observe machine operation, or for wash down purposes.

- (b) The design of the structural frame shall be based on a minimum belt tension of 9 kg/cm of belt width. The structural members shall be pressed or otherwise machine-formed in minimum AISI grade 304L stainless steel. The design of the load bearing structural members shall be such as to ensure a maximum deflection of $l/480$ where l is the span length, except in the case of roller support members, where the maximum permissible

deflection of the bearing support point from intentioned to tensioned state shall not exceed 2,5 mm. The maximum stress in structural elements shall not exceed one third of the yield stress.

The structural frame shall be designed to take all the horizontal loads imposed by the press components without external support from the press building, and all loads imposed on the building shall be vertical.

The frame shall be so designed and fabricated that roller alignment is determined by the frame geometry. The frame rigidity shall be such as to maintain roller alignment irrespective of movement of the supporting foundation.

Access platforms and the like shall be fabricated in mild steel to BS43C or ASTM A-36 specification, and suitably protected against corrosion as defined below. Adequate safe access, as required in terms of the OHS Act shall be provided for operation and maintenance of the equipment. The extent of the access platforms and ancillaries (i.e. ladders) shall be shown on a plan to be submitted with the tender.

The maximum overall length of the completely assembled press including cake conveyor and sludge conditioning tank shall not exceed 6 metres.

(c) Surface Finish

Matt finish stainless steel plate shall be used for the frame. On completion of welding work on the frame, all welds shall be acid-pickled. The pickling material shall be removed by steam cleaning after application.

After fabrication, the frame and other components fabricated in stainless steel shall be lightly sandblasted to provide a uniform, attractive external surface finish.

Pump support/base plates, access platforms and the like fabricated in mild steel shall be hot-dip galvanised to specification.

No galvanised materials shall be used inside the wetted area of the belt press.

(d) Bolts and other fasteners

All fasteners shall be 304L stainless steel. Where stainless steel bolts are fitted into structural carbon steel members, suitable anti-seize compound shall be applied to aid subsequent removal.

Fixing points for access platforms shall be provided.

(e) Odour Control

The filter belt press shall be designed and constructed in such a way as to provide maximum protection for operations staff against injury to health from the bio-hazards present in sewage sludge.

As a minimum, the thickening or dewatering unit shall be provided with a solid, impermeable containment enclosure on the four vertical sides, which shall be contiguous with a bottom enclosure or sump to contain all spent liquors.

A top enclosure or hood with suitable air extraction points shall be provided for the filter belt press.

The enclosed volume shall be minimised by restricting the maximum width and height dimension of the enclosure.

A minimum of two extraction points shall be provided, with at least one at the lowest point to extract gases which are heavier than air, and at least one on the uppermost surface of the unit.

The filter belt press shall be provided with watertight inspection hatches on the vertical sides of the enclosure at all points where the operator would normally require visual access during operation of the machine, and where access is required for operations such as replacing the filter belts. A minimum of one inspection hatch per 3 square metres of side frame area shall be provided.

Bearings or other mechanical or electrical equipment which would deteriorate in a moist environment shall not be located inside the enclosure in the wetted area of the press, or shall be designed to withstand the environmental conditions.

PTN 1.3.2 *Roller Construction and Bearing Selection*

- (a) The basic design criteria for rollers shall be:
- Maximum stress no more than 33% of the yield stress of the roller material, calculated at maximum belt tension.
 - Maximum centre span deflection of 0,5 mm/m of roller length, at maximum belt tension. The design tension shall be stated.
- (b) Roller material shall be AISI grade 304L stainless steel (nylon or rubber coated). Roller dimensions and stress calculations shall be provided on request.
- (c) Roller bearing shafts and end flanges shall be so designed as to transmit bearing loads to the outer periphery of the end flange without significant diaphragm mode deflection of the end flange.

Roller shafts shall be stressed on the assumption that the end flange is rigid. Sufficient information shall be provided to demonstrate the integrity of the end flange design. Where through shafts are proposed, the supplier shall demonstrate that the design provides adequate support to the through shaft to prevent bending, excessive stress, or fretting in service.

- (d) Bearing Selection

Bearings for drive, idle and press rollers shall be self-aligning spherical roller type, and shall accommodate a misalignment of up to 3 degrees included angle without reduction in capacity. Bearing inserts shall be stock sizes readily available from distributors and suppliers. A full list of bearings with identification type numbers shall be provided.

- (e) Bearing Selection Data

Bearing selection data showing the method of calculating L10 bearing life, and detailing methods of calculating bearing loads shall be submitted on request.

Bearings shall be selected for a L10 life of 100 000 hours minimum, using maximum operating speeds, and a belt tension of 9 kgf/cm belt width in each belt. Calculations shall also allow for roller self-weight and drive torque.

- (f) Bearing Housings

Bearing housings on all pressure, tension and guide rollers shall be of the horizontally split type, to permit replacement of inserts and seals in service without major dismantling. Bearing housings shall be provided with lip seals to prevent entrance of moisture and other contaminants. Suitable shaft seals shall be provided. Grease fittings shall be supplied to each bearing with remote stainless steel lines to allow lubrication when the unit is running.

Centralised grease lubrication system in 304L stainless steel shall provide a metered charge of grease to each bearing in turn from a centrally located lubricator.

PTN 1.3.3 *Sludge Conditioning*

(a) Sludge Conditioning

The linear screen/belt press system shall incorporate a system for efficient mixing of polyelectrolyte and sludge with the objective of minimising polyelectrolyte consumption. Polyelectrolyte shall be introduced at four points located radially on the sludge feed pipe.

Once the polyelectrolyte has been thoroughly mixed into the feed sludge the flow shall enter a conditioning tank.

The conditioning tank shall have an adequate capacity and be equipped with a gear-motor driven slow speed flocculator. The mixing arrangement shall ensure that the entire contents of the tank are uniformly agitated and shall prevent short-circuiting of sludge. Flocculation tanks without mechanical agitation, in which settled sludge solids may accumulate, will not be acceptable.

The conditioning tank shall be manufactured in grade 304L stainless steel.

(b) Sludge Distribution

Sludge from the flocculation/conditioning tank shall be conveyed onto the linear screen in such a manner as to avoid excessive turbulence and consequent floc break-up. The distribution mechanism shall be so arranged that the maximum static head loss between the top water level in the flocculation tank, and the linear screen shall not exceed 75 mm.

The distributor shall spread the sludge evenly over the working width of the linear screen. A mechanism shall be provided to ensure that the incoming sludge flow is spread evenly over the effective working width of the linear screen. Further mechanisms shall be provided to “plough” the sludge blanket so that the maximum degree of free drainage is achieved prior to the low pressure zone.

The sludge plough mechanism shall be so designed as to facilitate adjustment by the operator in safety and comfort. It shall be possible to remove the ploughs from the sludge blanket if considered necessary during operation.

A minimum of six rows of ploughs shall be provided.

PTN 1.3.4 *Sludge Handling*

(a) Dewatering Zones

The filter belt press shall be provided with three distinct dewatering zones as follows:

- Gravity dewatering zone, where the free water is removed completely from the conditioned sludge.

- Low pressure dewatering zone, or wedge zone, where the drained sludge is subjected to a gradually increasing pressure as the two dewatering belts converge.
- High pressure zone where the sludge is subjected to gradually increasing pressure.

The design of the dewatering zones shall permit a gradual increase in dewatering pressure after exiting the gravity zone. The first pressure stage shall be a wedge zone which shall be designed as to encourage run-off expressed water. Plastic wiper blades shall be positioned beneath the filter belt in this zone to assist water removal. Collection trays shall be positioned at entry to the first pressing stage to catch any material extruding sideways from the belts at this point, and to guide this material to the outlet sump.

Separate collection trays fabricated in grade 304L stainless steel or similarly corrosion-resistant material shall be provided to collect the filtrate from the gravity dewatering zone, from the wedge or low pressure dewatering zone, and from the belt wash system.

The design layout of the pressure zones shall be compact, with minimum filter belt area wasted in tangents between press rollers. Roller layout shall encourage run-off of expressed water, and where necessary wiper blades shall be provided to prevent re-wetting of the sludge cake.

A sump shall be provided to collect and contain the excess filtrate and wash water from the press. A flanged outlet adequately sized, and in no case less than 150 mm (6 inch) nominal diameter shall be provided. The sump may form part of the structural foundations. If it is part of the enclosure it shall be of stainless steel.

Note: For horizontal wedge zones the area of the wedge zone shall be calculated using one side of the belt only.

The area of the pressure zone shall be calculated as the contact area with the press rollers and shall not include any allowance for tangents between rollers.

(b) Sludge Cake Removal Blades

A mechanism shall be provided for removing the sludge cake from the filter belt. It shall be positioned clear of a roller surface to prevent damage to the belt seam. It shall be possible to adjust the degree of contact with the belt along the length of the blade. The blade shall be fitted with a means of adjustment to allow for wear. Blade material shall be an abrasion resistant plastic.

The blade support shall be sufficiently stiff to prevent deflection in service which would permit material to pass by.

Scraper blade inserts shall be reversible or refurbishable. Blade inserts shall be replaceable.

PTN 1.3.5 Filtrate Drainage System

(a) General Requirements

Discharge of filtrate onto the dewatering room floor, or any arrangement whereby spillages can discharge on to the floor, is unacceptable.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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Filtrate drainage from the gravity and pressure dewatering zones shall be contained within the confines of the unit and discharged via piping.

The filtrate pipework shall be connected to a closed pipe system which drains to the recovery sumps.

The filtrate and wash water shall be discharged separately.

(b) Drainage Pan Construction

Drainage Pans which are part of the enclosure shall be constructed in minimum 1,5 mm grade 304L stainless steel. Interconnecting pipework shall be in stainless steel or PVC or similar corrosion-resistant material.

PTN 1.3.6 Belt Wash System

A belt washing system shall be provided to ensure adequate cleaning of the filter belts and to prevent blinding.

- (a) The belt press shall incorporate a high pressure wash system operating at a minimum pressure of 6 bar. Spray nozzles shall be specifically designed for cleaning purposes, shall have a 'chisel jet' form, and shall have an overlapping pattern. The nozzle header shall be easily removable for cleaning and inspection, if required.
- (b) Spray bars shall be provided with a built-in cleaning brush, capable of being used while the filter belt press is in operation. The press control system shall monitor the spray water pressure, and shall incorporate a variable delay period to prevent nuisance shutdown while the cleaning brushes are in use. A suitably sized filter/strainer shall be provided on the wash water supply line.
- (c) An adjustable pressure switch shall be provided sensing the post-filter wash water pressure. This shall be wired to the belt press control system and shall shut down the dewatering system in a sequenced manner if wash water pressure falls below the present value.

PTN 1.3.7 Control Systems

The requirements of this section are to be read in conjunction with Volume 3 and Section PTW.

(a) General Requirements

The control supplied with the belt press shall perform the following functions:

- (i) Maintain filter belts in alignment under all operating conditions.
- (ii) Control start-up and shut-down sequencing.
- (iii) Indicate the following fault conditions:
 - Belt off track
 - Failure of belt tracking limit switches
 - Drive motor tripped on overload etc
 - Wash water pressure below preset value
 - Wash pump water supply failure
 - Polyelectrolyte delivery failure (loss of polyelectrolyte injection pressure or polyelectrolyte pump tripped/off)
 - Polyelectrolyte supply low level in dosing tank

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- Belt breakage/Loss of Belt tension
 - Loss of sludge flow (Sludge No-Flow detection)
 - Loss of flocculation (failure of mixer)
 - Discharge System Failure (Conveyor failure)
- (iv) Permit remote sequenced start/stop operation, e.g. from a timer or process control computer.
- (v) Accept interlocks from other ancillaries such as conveyors etc.
- (vi) Provide relay contacts for remote alarm indication.

The filter belt press control system is required to be incorporated into a Motor Control Centre. The control system shall be based on PLC technology. Volt free relay contacts shall be provided for automatic control and sequencing of belt press drive, sludge mixer/flocculator, wash water pump (or solenoid valve), sludge feed pump, polyelectrolyte feed pump, and sludge cake discharge system. Relays shall be plug-in industrial type operating on 24 volts DC with a minimum contact rating of 5A at 250 V AC.

It shall be possible to change the operating sequence or enunciator functions without field wiring alterations. Timer relays shall not be used for sequencing.

(b) Belt Alignment Controls

The belt alignment system shall comprise a slewing guide roller on each belt. The control mechanism shall not require either excessive belt wrap angles around the guide roller, or excessive slew travel, which would lead to belt deformation and wear.

An alignment system will be provided which anticipates belt movement and takes corrective action proportional to belt drift.

The slewing mechanism shall comprise an actuator coupled directly to the bearing housing on the slewing roller.

The slewing bearing housing shall be provided with low-friction tracks.

A pair of sensors for each belt shall be provided to sense a shutdown misalignment condition. The control logic shall prevent nuisance shutdown from occasional activation of these sensors.

PTN 1.3.8 Belt Tensioning

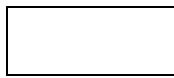
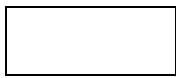
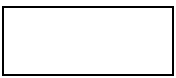
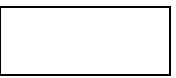
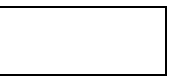

Belt tension shall be adjustable from the minimum required for correct belt tracking up to the maximum design value. The range of adjustment shall be from approximately 2 to 10 kg/cm and shall be compatible with the values used in the bearing selection and roller stressing calculations. Adjustment of belt tension shall be manual at the machine.

PTN 1.3.9 Belt Drive

The belt drive arrangement shall provide positive drive for each filter belt.

The transmission mechanism shall be totally enclosed, oil tight, and oil or grease lubricated.

The overall efficiency of the gearbox and final drive arrangement shall be in excess of 90%. The drive system shall be one of the following:

					
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- Either a single drive direct-coupled to one press roller, and with a chain transmission to the second roller, OR
- Dual drives, one for each belt, synchronously driven from a common variable frequency three-phase drive.

Speed variation will preferably be by means of a variable frequency inverter in the Belt Press control panel of the Motor Control Centre.

PTN 2 POLYELECTROLYTE MAKE-UP SYSTEM

The polyelectrolyte make-up installation shall be designed to make up a 0,25% dosing solution from a powdered polymer. The powdered polymer will be either a gel or beads.

The same polyelectrolyte will be used for both digested primary and waste activated sludge. A single polyelectrolyte make-up system is therefore required.

Polyelectrolyte will be delivered in 1 m³ maxi bags.
The polyelectrolyte make-up system comprises a feeder, transfer blower and jet-wet head. The system shall be either a batch or continuous system as described below. It shall be capable of accurately making up the desired concentration of a powdered polyelectrolyte within an accuracy of 5% without the necessity to charge the feeder hopper with a manually weighed out mass of chemical. The polyelectrolyte solution shall be made from either beads or a gel.

The transfer blower and jet-wet head shall be supplied by a specialist and shall be capable of transferring and wetting the mass of polyelectrolyte powder efficiently and without spillage and the formation of “fish eyes”.

The feeder, eductor and transfer system shall be heated to avoid the precipitation of moisture and the formation of gelatinous deposits.

The feeder shall be a rotary vane feeder. The feeder shall be totally enclosed and shall dispense a measured amount of polyelectrolyte gel or beads with a repeatability of 5%.

The installation shall allow for easy removal for cleaning.

The proposed systems are as follows:

PTN 2.1 Batch System

A maxi bag is placed on a platform above the dry feeder and powdered polyelectrolyte gravitates into the feeder hopper.

The equipment comprises the following:

- (i) Loading platform to accommodate a single maxi bag.
- (ii) Rotary vane feeder suitable for feeding a powdered polyelectrolyte with an SG of between 0,8 and 1,2.
- (iii) A transfer blower to transfer the powder to the wetting unit.
- (iv) A polyelectrolyte eductor.
- (v) A wetting unit.

- (vi) All piping and fittings required for conveying the polyelectrolyte from the feeder to the wetting unit.
- (vii) All water supply piping, fittings manual flow control and electrically actuated valves, pressure reducing valve, etc. Piping from a point 1 m outside the building to the polyelectrolyte make-up system and to the polyelectrolyte dosing pumps for dilution water shall be supplied under this contract.

All suction and delivery valves to the polyelectrolyte transfer pumps shall be fitted with position indicators to indicate the position, open/closed, of the valve.

The rotary vane feeder, polyelectrolyte eductor, transfer blower and wetting head shall be capable of feeding a powdered polyelectrolyte having an SG of between 0,8 and 1,2 at a rate specified in the Project Specifications.

The speed of the rotary vane feeder shall be manually adjusted by the operator to achieve the required solution strength.

The polyelectrolyte transfer pumps shall be positive displacement pumps. A manually operated flushing connection shall be provided to flush the system with service water. Position indicators are not required on the flushing valves.

PTN 2.2 Continuous System

A maxi bag is placed on a platform above the dry feeder and powdered polyelectrolyte gravitates into the feeder hopper.

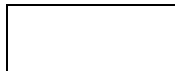
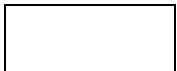
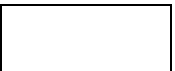
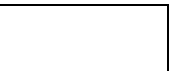
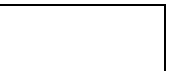
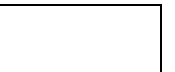
The equipment comprises the following:

- (i) Loading platform to accommodate a single maxi bag.
- (ii) Rotary vane feeder suitable for feeding a powdered polyelectrolyte with an SG of between 0,8 and 1,2.
- (iii) A transfer blower to transfer the powder to the wetting unit.
- (iv) A polyelectrolyte eductor.
- (v) A wetting unit.
- (vi) All piping and fittings required for conveying the polyelectrolyte from the feeder to the wetting unit.
- (vii) All water supply piping, fittings flow control and actuated valve, pressure reducing valve, and flow meter. Piping from a point 2 m outside the building to the polyelectrolyte make-up system and to the polyelectrolyte dosing pumps for dilution water shall be supplied under this contract.

The rotary vane feeder, polyelectrolyte eductor, transfer blower and wetting head shall be capable of feeding a powdered polyelectrolyte having an SG of between 0,8 and 1,2 at a rate of:

The rotary vane feeder shall be a totally enclosed unit driven by a variable speed motor capable of an accuracy of $\pm 5\%$.

The speed of the rotary vane feeder shall be automatically set in accordance with the rate calculated by the automatic control system or as set by the operator.

					
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PTN 3 CHEMICAL DOSING SYSTEMS

One chemical dosing system is required to dose polyelectrolyte to the belt presses and linear screen.

PTN 3.1 Polyelectrolyte Dosing System

The polyelectrolyte dosing pumps draw a 0,25% polyelectrolyte solution from the dosing tank. A separate dosing pump shall be provided for each of the linear screen/belt press units. A single store spare is also required.

Each polyelectrolyte dosing line shall be fitted with a magnetic flow meter.

After metering, the polyelectrolyte solution is diluted by the addition of sufficient water to produce a 0,1% solution at the maximum specified dosing rate. The rate of flow of dilution water will be manually set at a diaphragm valve and a rotameter. Dilution water and polyelectrolyte shall be intimately mixed by means of an in-line mixer.

The equipment required is as follows:

- (a) Suction and delivery manifolds, fittings and valves.
- (b) Dilution water piping connection and diaphragm valve for dilution water control to each of the dosing points including dilution water rotameter for each line. Each dilution water line shall have an automatically actuated (open/closed) valve.
- (c) Injection rings and mixers for mixing the dilute polyelectrolyte solution into each of the sludge feed lines.
- (d) A magnetic flow meter to measure total flow of dilution water.

PTN 3.2 Dosing Pumps and Flushing Water Connection

The polyelectrolyte dose pumps shall be positive displacement pumps, either peristaltic or progressive cavity pumps.

They shall be suitably sized to limit the shear imparted to the chemical being dosed.

All dose pumps shall be fitted with a manual valved flushing water connection to flush the system with service water. Position indicators are not required on the flushing valve.

PTN 4 PROCESS WATER SUPPLY

PTN 4.1 Description of the System

The description of the system is described in the Project Specification.

PTN 4.2 Protection against corrosion

All equipment in contact with water or exposed to the weather shall be either made of non-corrodible materials or protected against corrosion in accordance with the Specifications.

PTN 5 DRY SLUDGE CONVEYORS

PTN 5.1 Design Requirements

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The Contractor shall design and supply sludge conveyance and storage systems in accordance with the following requirements:

- The conveyance and storage systems shall be capable of handling the masses of sludge at the dry solids concentrations given in the Project Specification.
- The masses and volumes of storage required for each of the sludges are given in the Project Specification.
- The conveyance and hopper loading system shall make provision for the distribution of dry sludge over the entire bunded storage area by means of traversing pivot system.
- Access shall be provided for maintenance. In particular access shall be provided to all motors, gearboxes and bearings and to the conveyors for replacement of wearing parts and linings.

PTN 5.2 Spares Required

The following spares shall be provided:

PTN 5.2.1 For screw conveyors

- (i) A spare flight for each length of screw conveyors.
- (ii) A spare set of bearings for each conveyor.
- (iii) Spare motor/gearbox for each size of conveyor.

PTN 6 CONTROL PHILOSOPHY

An automatic control system shall be provided with control via the master PLC. The system shall be able to interface with the SCADA system, from which the operator can monitor and control the operation of the dewatering plant. Where reference is made to the SCADA system, and/or information on the process is required, the Tenderer shall make these signals and information available to the SCADA for future incorporation.

Where the condition of drives are described as “fail to start” or “fail”, this shall also be taken to mean that the drive is “not available”. These conditions may be due to a trip or fault condition, that the duty selector has been switched to the “OFF” position, or that the drive has been isolated.

The control system shall embody the features set out below.

PTN 6.1 Polyelectrolyte Make-Up

PTN 6.1.1 Batch make-up system

- The operator is required to set the mass of polyelectrolyte to be made up per batch and the solution concentration.
- The levels of the make-up and dosing tanks shall be monitored by ultrasonic measurement and shall be indicated at the SCADA.
- Each valve shall have a position indicator and the position of the valve shall be indicated on the SCADA. If the valves associated with the selected duty pumps are not open, an error shall be indicated and the system shall not start. If the valves on the standby pump are not open an error shall be indicated, the plant shall, however, start/continue to operate. If failure of a duty pump occurs and the standby pump is required for duty and its valves are incorrectly set an alarm shall be indicated and, if the

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error is not corrected by the time the control system calls for the pump to start, an emergency alarm shall be indicated.

- When the level of the dosing tank drops to a preset low level, automatic make-up of a batch of polyelectrolyte shall commence.
- The flow of water to the jet wet head and to fill the tank shall start, i.e. the polyelectrolyte make-up pumps shall start, and the appropriate solenoid valves controlling flow to the make-up tank and jet-wet head shall open.
- Polyelectrolyte transfer blower shall start.
- After the level of water in the make-up tank has risen a pre-set small amount the polyelectrolyte feeder shall start and dispense a preset mass of polyelectrolyte powder, measured on a time basis. The feeder shall then stop followed by the blower and the water supply to the jet wet head.
- The mixer in the make-up tank shall run at all times unless the level of liquid in the tank is below a low-low level.
- When the liquid level in the tank reaches a preset high the water supply to the tank shall cease, i.e. the polyelectrolyte make-up pumps shall stop and the appropriate valves shall close.
- The control system shall indicate the concentration of the polyelectrolyte solution. This concentration shall be calculated by using the quantity of poly powder dispensed into the make-up tank (according to the length of run-time) and the amount of water added.
- The preset mass/time of polyelectrolyte added shall be adjustable at the SCADA, such adjustment shall be password protected.
- When the level of liquid in the dosing tank drops to a preset low level the duty transfer pump shall start and shall fill the dosing tank. Duty and standby transfer pumps shall cycle automatically. If the duty pump fails to start the standby pump shall start automatically and a signal to this effect shall be displayed on the SCADA. If the standby pump fails to start an alarm shall be indicated at the SCADA.
- The transfer of polyelectrolyte shall stop when the level in the make-up tank drops to a low level or when the level in the dosing tank reaches a high level.
- Alarms shall be initiated when low-low or high-high levels occur in either of the tanks.
- The preset levels shall be adjustable at the SCADA, such adjustments shall be password protected.
- The position, open/closed of all pump suction and delivery valves shall be indicated at the SCADA.

Alarms shall be indicated under the following conditions:

- (i) If the polyelectrolyte transfer blower fails to start.
- (ii) If a polyelectrolyte transfer pump fails to start.
- (iii) If the mixer in the polyelectrolyte make-up tank fails.
- (iv) If the rotary vane feeder fails to start.

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- (v) If the duty or standby polyelectrolyte transfer pumps fail to start.
- (vi) If after initiation of the make-up of a batch of polyelectrolyte and initiation of the water supply to the make-up tank, the ultrasonic detects that the level fails to rise.
- (vii) If the valves are incorrectly set for the duty and standby pumps.
- (viii) If on start-up the valves are incorrectly set and the plant shall not start.
- (ix) If during operation the position of the valves of the duty pump are changed so as to compromise the operation of the pump the duty pump shall be switched off and the standby pump shall be started, provided that its valves are correctly set.
- (x) If during operation the position of the valves on the standby pumps are altered so as to compromise the operation of the pump.

The dewatering plant shall shut down automatically if the level in the dosing tank drops to a pre-set emergency low-low.

PTN 6.1.2 Continuous make-up system

- The operator is required to set the rate of polyelectrolyte make-up, say 10 kg/h, and the required concentration of dosing solution, say 0,25%.
- The make-up of polyelectrolyte shall commence when the polyelectrolyte dosing pumps are started. The solenoid valve supplying water to the make-up system shall open, the polyelectrolyte transfer blower shall start, the polyelectrolyte feeder shall start, and the mixers to the make-up tanks shall start.
- The speed of the polyelectrolyte feeder shall be automatically set to achieve the correct rate of chemical feed. The rate of make-up water addition shall also be automatically set as measured by the flow meter and adjusted by the diaphragm valve.
- The polyelectrolyte blower shall operate continuously during operation of the make-up system.
- All mixers shall operate continuously.
- The make-up of solution shall cease if the level in the dosing tank rises to a preset high level and an alarm shall be indicated.
- Make-up of solution shall recommence when the level in the dosing tanks drops to a preset operating level.
- If the level in the dosing tanks continues to fall an alarm shall be indicated that the selected make-up rate is inadequate and should be increased. If the level in the dosing tank drops to a pre-set low-low level the dewatering plant shall shut down.
- The preset levels shall be adjustable at the SCADA, such adjustments shall be password protected.
- The rate of flow of the polyelectrolyte make-up water shall be indicated on the SCADA and recorded graphically.
- The continuous make-up system shall stop when the dewatering plant is shut down. In the event that the Tenderer proposes the continuous make-up system, he shall state

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the measures taken to prevent made-up polyelectrolyte remaining in the holding tank for any length of time.

PTN 6.2 Belt Presses and Polyelectrolyte Dosing rate

The system shall cater for two alternative systems as described below:

PTN 6.2.1 System 1: Constant solids loading

NOTE: For this system the solids mass feed rate to the linear screens/belt presses is maintained at a constant preset rate. The flow rate into the pipes is varied in accordance with the sludge concentration. The polyelectrolyte dose remain constant.

- (i) The operator shall set/select the following at the SCADA:
 - (1) The belt press trains comprising linear screen/belt press and polyelectrolyte dosing pump that is required to operate.
 - (2) For each operating train, whether digested primary or waste activated sludge is to be dewatered.
 - (3) The polyelectrolyte dosing rate in kg/ton of dry sludge for primary and for waste activated sludge.
 - (4) Set the required sludge feed rate per operating train for digested primary and for waste activated sludge in kilograms of dry solids per hour.
- (ii) The automatic control system of the master PLC shall then:
 - (1) Calculate the required sludge feed rate for each linear screen/press and the total sludge feed rate for waste activated and digested primary sludge in accordance with the solids concentration and the required solids feed rate.
 - (2) Calculate the required polyelectrolyte pumping rate in accordance with the polyelectrolyte solution concentration and the required dosing rate as set by the operator.
 - (3) Initiate the start-up sequence for each of the selected linear screens/belt presses (the master PLC shall provide the initiation only, after which the individual PLC's dedicated to each of the presses shall start-up the presses).
 - (4) Open the washwater valves to the selected linear screens/belt presses.
 - (5) Open the suction and delivery valves on the selected polyelectrolyte dosing pumps.
 - (6) Open the dilution water supply valves to the selected polyelectrolyte dosing pumps.
 - (7) Start and adjust the speed of the sludge feed pumps to achieve the target pumping pressure.
 - (8) Adjust the feed rate of sludge to each belt press to achieve the selected solids feed rate.
 - (9) Start and adjust the speed of the polyelectrolyte dosing pumps to maintain the preset dose.

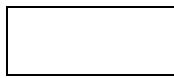
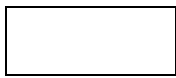
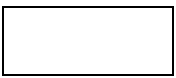
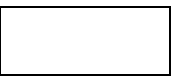
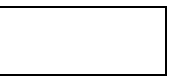

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- (10) For the continuous make-up of polyelectrolyte dosing solution the following is also required:
 - The system shall calculate the mass of polyelectrolyte required to achieve the targets of mass feed rate and polyelectrolyte dosing rate previously set by the operator.
 - Indicate an alarm if the rate calculated above is greater than that set by the operator.

PTN 6.2.2 **System 2: Constant hydraulic loading**

NOTE: For this system the hydraulic flow into the linear screens/presses is kept at a constant preset rate. Polyelectrolyte dose is varied according to feed solids concentration.

- (i) The operator shall set the following at the SCADA:
 - (1) The belt press trains comprising linear screen/belt press and polyelectrolyte dosing pump that is required to operate.
 - (2) For each operating train, whether primary or waste activated sludge is to be dewatered.
 - (3) The polyelectrolyte dosing rate in kg/ton of dry sludge for primary and for waste activated sludge.
 - (4) Set the required flow rate per train for primary and for waste activated sludge in m³/h.
- (ii) The automatic control system of the master PLC shall then:
 - (1) Calculate the required polyelectrolyte pumping rate in accordance with the polyelectrolyte solution concentration and the required dosing rate as set by the operator.
 - (2) Initiate the start-up sequence for each of the selected linear screens/belt presses (the master PLC shall provide the initiation only, after which the individual PLC's dedicated to each of the linear screens/presses shall start-up the presses).
 - (3) Open the washwater valves.
 - (4) Open the suction and delivery valves on the selected polyelectrolyte dosing pumps.
 - (5) Open the dilution water supply valves to the selected polyelectrolyte dosing pumping pressure.
 - (6) Adjust the feed rate of sludge to each belt press to achieve the selected hydraulic feed rate as measured by the individual flow meters.
 - (7) Adjust the speed of the polyelectrolyte dosing pumps to maintain the preset dose. This calculated from the concentration of the dosing solution, the feed rate as measured by the individual flow meters and the sludge concentration as measured by the solids density meters.
 - (8) Adjust the speed of the sludge feed pumps to achieve the target pumping rate.

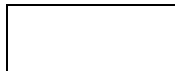
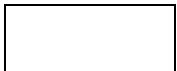
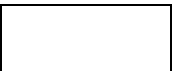
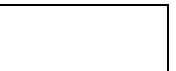
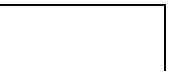
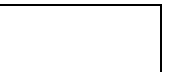
					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

For the continuous make-up of polyelectrolyte dosing solution the following is also required:

- (i) Calculate the total amount of polyelectrolyte dosed over the last hour.
- (ii) Calculate the “life” or hours of operation of a full polyelectrolyte dosing tank.
- (iii) Indicate an alarm if the “life” calculated in (b) is less than a preset time say 6 hours. The preset time shall be adjustable at the SCADA. The setting shall be password protected.

PTN 6.2.3 For both systems

- (i) Each linear screen/belt press shall be equipped with its own field control panel. The size of these panels shall be adjusted to accommodate all controls to two linear screen/belt presses as required by the supplier, but shall, as a minimum allow the operator to do the following:
 - (1) Switch from “Auto” to “Manual”.
 - (2) The press parameters may now be controlled via incremental step push buttons on the control panel, with feedback of per unit adjustment for the various parameters.
 - (3) The sludge feed rate may be varied.
 - (4) The poly dosing rate may be varied.
 - (5) Once these parameters have been adjusted, and the operator switches back to “Auto”, these parameters will be followed, overriding the automatic settings previously set.
 - (6) Once the press has been shut down, the automatic settings will take preference again, until changed by the operator in the above fashion.
- (ii) The SCADA shall indicate an alarm when:
 - (1) The polyelectrolyte dosing pumps reach their maximum speed.
 - (2) The feed rate to the linear screen/belt press reaches a preset high.
 - (3) A shut-down sequence or trip signal is initiated on a linear screen/belt press by the respective individual PLC.
- (iii) The shut down procedure shall be as follows:
 - (1) Close the sludge feed valve to the linear screen/belt press.
 - (2) Stop the polyelectrolyte dosing pumps.
 - (3) Close the polyelectrolyte dilution water valve.
 - (4) Close the washwater valve.
 - (5) Stop the linear screen/belt press. Under normal shutdown conditions (other than a trip signal) the master PLC shall initiate the shutdown, with the individual linear screen/press PLC performing the shutdown sequence.
- (iv) The plant shall be automatically shut down if the following conditions occur:

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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- (1) The polyelectrolyte feed fails.
- (2) The washwater pressure is too low.
- (3) The linear screen or belt press fails.
- (4) The dry cake conveyors fail.

The master PLC shall then give the signal to the individual PLC's of each press in operation to initiate the shutdown sequence of the respective presses.

- (v) The control systems shall record and indicate the following graphically on the SCADA:
 - (1) The total hydraulic flow and mass of sludge, as obtained from the solids density meters, for both primary and waste activated sludge and the waste activated sludge washwater linear screen.
 - (2) The flow of washwater and filtrate and the mass of sludge lost via the washwater and filtrate, as measured by the solids density meters, for both primary and waste activated sludge.
 - (3) The moisture content of the primary and waste activated sludge dry cake.
 - (4) The mass of polyelectrolyte dosed in kg/t for both sludges.

Based on the data the system shall calculate and record a daily mass balance indicating for both primary and waste activated sludge:

- (i) The mass of dry sludge treated.
- (ii) The mass of dry sludge in the washwaters.
- (iii) The mass of dry sludge in the filtrates.
- (iv) The consumption of polyelectrolyte in terms of mass of sludge applied to the dewatering units, and the mass of sludge actually recovered, both masses as dry solids.
- (v) The average concentration of the dry cake.

PTN 6.3 Linear Screen and Polyelectrolyte Dosing

- (a) It shall be possible for the operator to set the following at the SCADA:
 - (i) Required flow rate.
 - (ii) Required polyelectrolyte dosing rate in kg/t.
- (b) When start up of the sludge feed pumps is initiated the automatic system shall:
 - (i) Via the master PLC's provide a start signal to the screen PLC to initiate the start sequence of the linear screen.
 - (ii) Open the linear screen washwater valve.
 - (iii) Open the polyelectrolyte dilution water valve.
 - (iv) Start the sludge pumps.

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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- (v) Start the duty polyelectrolyte dosing pump.
- (c) During operation the control system shall:
 - (i) Adjust the speed of the sludge pumps to achieve the target flow rate.
 - (ii) Adjust the polyelectrolyte pumps to achieve the target dosing rate.
- (d) The following parameters shall be indicated on the SCADA and displayed graphically:
 - (i) Pump flow rate.
 - (ii) Solids concentration of the pump delivery.
 - (iii) Flow rate of the filtrate and washwater.
 - (iv) Solids concentration of the filtrate and washwater.
 - (v) Mass of solids applied to the linear screen.
- (e) The following alarms shall be indicated:
 - (i) Low washwater pressure.
 - (ii) Failure of any equipment to start.
 - (iii) Inability to achieve either the target flow or polyelectrolyte dosing rate.
- (f) When shut down of the linear screen is initiated the system shall:
 - (i) Close the sludge feed valve to the linear screen. Stop the duty polyelectrolyte pump.
 - (ii) Stop the recycle pumps.
 - (iii) Close the polyelectrolyte dilution water valve.
 - (iv) Close the washwater valve.
 - (v) Subsequent to shutting down of the screen by its own PLC, it shall return a "Screen stopped" signal to the master PLC.
 - (vi) Adjust the speed or stop the sludge feed pumps.
- (g) In the event of failure of the following equipment, the linear screen thickening system shall be automatically shut down, with the master PLC signalling the screen PLC to stop the screen and an alarm shall be indicated:
 - (i) The polyelectrolyte pump.
 - (ii) The washwater supply.
 - (iii) Failure of the sludge pumps.
 - (iv) Failure of the belt presses.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2
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PTN 6.4 Process Water System

In-line filter:

The pressure transducers fitted to the filter inlet and outlet piping shall monitor the pressure drop across the filters. When the pressure drop across the filters reaches a preset high the filter shall be backwashed automatically. The status of the filter, in service or being washed, and the position of the valves shall be indicated on the SCADA. The rate of flow, and cumulative volume, of backwash water shall be indicated on the SCADA.

PTN 6.5 Sludge Conveyors

The operator shall select the duty conveyors at the SCADA.

The selected conveyors shall start.

If a fault occurs on any of the conveyors an alarm shall be indicated. The operator shall then make the necessary adjustments to the settings of the equipment and sludge discharge from the belt presses to the selected conveyor and initiate restart of the equipment.

All screw conveyors shall be equipped with electronic overload protection for over torque conditions. Should an over torque occur, the screw shall stop and run in reverse for a set period of time, stop, and then run forwards again. If the condition still persists, the screw shall again repeat the reverse/forward cycle. The drive shall repeat this cycle three times before locking out on an over torque alarm.

PTN 6.6 Order of Start-up and Shut Down

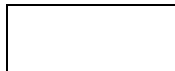
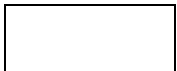
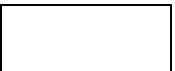
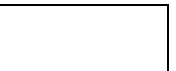
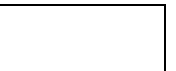
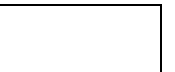
The start up and shut down sequence of the various plant elements has been described previously. The start up and shut down sequences of the plant as a whole shall be in accordance with the requirements of the equipment and shall generally be as follows:

(a) Start-up:

- (i) The washwater to the linear screens and the belt presses shall start.
- (ii) The linear screen shall start, with the master PLC signalling the individual screen PLC's to initiate their start-up segment.
- (iii) The belt presses shall start, with the master PLC signalling the individual press PLC's to initiate their start-up sequence.
- (iv) Sludge conveyors shall start.
- (v) Polyelectrolyte dilution water flow shall start.
- (vi) Sludge feed shall commence.
- (vii) Polyelectrolyte dosing shall start.
- (viii) Polyelectrolyte continuous make-up system shall start.

(b) Shut down:

- (i) Polyelectrolyte dosing and sludge flow shall stop.
- (ii) Polyelectrolyte dilution water flow shall stop.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

10 PTN - Sludge Dewatering Equipment - June25

- (iii) Washwater flow to the linear screens and belt presses shall stop.
 - (iv) Sludge conveyors shall stop.
 - (v) Master PLC shall signal the individual press PLC's to initiate the shutdown sequence for the presses, and the Belt presses shall stop.
- (c) Emergency shut down:
- The primary and/or waste activated sludge dewatering plant shall shut down completely if:
- (i) The conveyors fail.
 - (ii) The sludge feed pumps are not operational.
- (d) An alarm shall be indicated and the plant, or the affected linear screens and belt presses shall be shut down unless remedial action resolves the problem within 10 minutes if:
- (i) The washwater supply fails.
 - (ii) The polyelectrolyte dosing system fails.
 - (iii) The continuous polyelectrolyte make-up system fails.
 - (iv) The polyelectrolyte dosing tank is empty.
 - (v) The polyelectrolyte dilution water supply fails.

PTN 7 CONNECTIONS AND ACCESSORIES REQUIRED FOR THE PROPER OPERATION OF THE PLANT

Connections for pipework on the linear screen and filter belt press units shall be suitable for the pipe layout as shown on the drawings.

The layout envisages two rows of dewatering equipment. All pipework is located centrally between the two rows of equipment. The pipework shall be located on support plinths just above floor level for ease of maintenance and replacement. Adequate clear space shall be provided between pipes and fittings to allow for access for maintenance and removal/replacement of all piping, valves and fittings. A travelling crane is provided to assist with the installation, maintenance and replacement of piping, valves and fittings. The tenderer is required to indicate on a drawing, submitted with his tender, his proposed pipework within the building.

Washwater and filtrate shall be discharged via the closed pipe systems, as shown on the drawings.

PTN 8 SUPPORT STRUCTURES, ACCESS AND GUARDS

Support and access structures, stairs and walkways shall provide access to the linear screen and drive, flocculation chamber and mixer and provide access to the filter belt press components and drive, feeder blade and to all other equipment.

The access structure shall allow for access to each belt press and linear screen and to all mechanical components. The structure shall be elevated at a level which will provide an

unrestricted view across the full width of the unit and the material on the screen and belt press feed zone and which will allow at least 2,1 m free walking height underneath.

The support and access structure shall be robustly constructed from carbon steel section and be hot-dip galvanised. Access walkways shall be of width not less than 750 mm equipped with kick plate, access stairs and mild steel open flooring and handrailing (open flooring shall be in hot-dip galvanised steel, and handrailing shall be grade 304L stainless steel). The walkways shall form one complete interconnected system.

In addition to the requirements of the Occupational Health and Safety Act, all drives and pinch zones between belts and rollers shall be fully enclosed with a robust guard manufactured from expanded steel mesh. The guards shall be provided with a robust frame and hinge arrangement to permit free access to equipment for maintenance and repairs.

Expanded steel guards shall be hot-dip galvanised, unpainted.

Solid guards shall be painted as specified in the Project Specifications.

PTN 9 VALVE ACTUATORS

Automatically operated valves that are either fully open or fully closed may be fitted with either electrical or pneumatic actuators.

Automatically operated valves for flow control shall be fitted with electrical actuators. Where solenoid valves are required, actuated on/off valves may be substituted.

The instrument air supply system shall be designed by the Contractor.

The system shall comprise:

- (i) Duty and standby compressors.
- (ii) Air receiver.
- (iii) Filters.
- (iv) Moisture traps.
- (v) Pressure gauges and pressure switches.
- (vi) Piping, valves, etc.
- (vii) All equipment required for the efficient operation of the plant.

PTN 10 TESTING OF EQUIPMENT

The contractor shall carry out the following performance testing, in the presence of the Engineer, prior to the commencement of the one-month operational acceptance period.

PTN 10.1 Rotary Vane Feeder and Polyelectrolyte Dosing Pumps

Calibration curves shall be produced throughout the operating range to demonstrate the repeatability of the performance.

After the plant has been operating for 1 month the calibration curves shall be produced. The second curve shall not deviate from the first by more than 5%.

PTN 10.2 Jet-wet Head

Satisfactory performance shall be indicated by the absence of “fish eyes” in the polyelectrolyte solution.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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PTN 10.3

Dewatering Equipment (linear screen/belt press)

After commissioning, the dewatering equipment shall be subjected to a 48-hour acceptance test to demonstrate compliance with the specification.

- (a) The following measurements shall be taken every two hours:
- (i) Flow rate to each belt press.
 - (ii) Sludge feed solids concentration.
 - (iii) Volatile solids concentration of the waste activated sludge feed.
 - (iv) Polyelectrolyte consumption.
 - (v) Solids concentration of the filtrate.
 - (vi) Solids concentration of the washwater.
 - (vii) Filtrate flow.
 - (viii) Washwater flow.
 - (ix) Solids concentration of the dry cake on a mass basis.
 - (x) Polyelectrolyte dilution water flow rate.
- (b) The Contractor shall submit calculations showing the performance of the dewatering equipment with respect to:
- (i) Solids loading.
 - (ii) Polyelectrolyte consumption in kg/tds.
 - (iii) Solids recovery as a percentage of feed solids.
 - (iv) Solids concentration of the dry cake.

The tests shall be repeated at the conclusion of the maintenance period if required by the Engineer.

PTN 10.4

Payment for Performance Testing

Payment shall be by Unit or Lump Sum as scheduled.

The rate tendered shall include for all costs associated with the tests including all plant, materials, equipment, measuring instruments, consumables, labour and laboratory testing.

END OF SECTION

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

PLQ: CORROSION PROTECTION OF STEEL PIPES AND FITTINGS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PLQ CORROSION PROTECTION OF PIPES AND FITTINGS

PLQ 1 SCOPE

This specification covers various corrosion protection systems for cast iron, steel and stainless steel pipes and fittings for the conveyance of water at ambient temperatures.

PLQ 2 CORROSION PROTECTION SYSTEMS

The following corrosion protection systems shall apply unless otherwise specified on the drawings, project specifications and schedule of quantities.

PLQ 2.1 Buried steel pipework

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized unless otherwise specified.

After installation, the pipework shall be protected with a Denso HT Petrolatum tape wrapping system as specified in this specification.

- b) Pipe diameter larger than 150mm

Specials, fittings and couplings shall be lined and coated with epoxy paint.

After installation the specials and fittings shall be protected with the Denso Ultraflex 1250/300 and MDP 032 tape wrapping system as specified in PLQ 11.1.

Standard pipe lengths shall be lined with epoxy paint and coated with fusion bonded medium density polyethylene (MDPE) or Bituguard or 3LPE as specified in this specification unless otherwise specified in the Project Specifications or the Bill of Quantities or on the Drawings.

PLQ 2.2 Pipework inside chambers

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

The outside end of fittings cast into the walls of the chamber shall be protected with a Denso HT Petrolatum tape wrapping system.

- b) Pipe diameter larger than 150mm

Fittings, specials and couplings shall be coated and lined with epoxy paint.

The outside end of the fitting cast into the wall as well as couplings outside the chamber shall be protected with a Denso HT Petrolatum tape wrapping system.

PLQ 2.3 Pipework exposed to sunlight

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable silver polyurethane acrylic site application.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

After installation the pipe shall be painted with re-coatable silver polyurethane acrylic.

- b) Pipe diameter larger than 150mm

Pipework shall be lined with epoxy paint.

Pipes shall be coated in the factory with two component inorganic zinc silicate primer (100 micron) plus one coat of silver polyurethane acrylic (60 micron).

A second coat of polyurethane acrylic (60 micron) must be applied on site. The inorganic zinc silicate must be repaired with "single pack zinc rich epoxy primer".

PLQ 2.4 Exposed pipework inside buildings

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable polyurethane site application.
After installation the pipe shall be painted with re-coatable polyurethane to the Employers colour coding specification.

- b) Pipe with diameter larger than 150mm

Pipes, fittings and couplings shall be lined and coated with epoxy paints.

After installation the pipework shall be painted with re-coatable polyurethane to the Employers colour coding specification.

PLQ 2.5 Pipework inside water retaining structures

All stainless steel pipework inside water retaining structures and cast into the walls or floor of water retaining structures shall be lined and coated with epoxy paint.

All stainless steel shall be 316L.

PLQ 3 SURFACE PREPARATION

Contractors must submit information on the cleaning methods to be used in meeting the specified requirements. Contractors must further provide the Engineer with the manufacturer's guarantee that the requirements have been met.

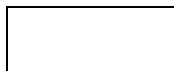
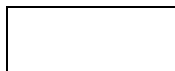
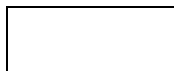
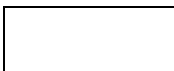
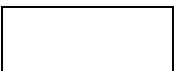
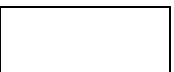
PLQ 3.1 Surface preparation of steel surfaces

All projections, sharp edges, layers that have formed and tool marks must be removed from the surface so that the surface is smooth, and it must be abrasive blast cleaned in accordance with sections 2, 3 and 4 of SABS Code of Practice 064 so that it meets the following requirements:

- (a) A grade of cleanliness of Sa 3 of ISO 8501-1 when tested by SABS test method 767.
- (b) A surface profile between 60mm and 85mm when tested by SABS test method 772.
- (c) Free from dust and debris to at least 0,2% when tested by SABS test method 769.

PLQ 3.2 Surface preparation of galvanized surfaces

Surfaces to be coated shall **not** be passivated.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SABS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.

Large areas shall be prepared by sweep-blasting with non-metallic abrasive. Cracking, flaking or any form of de-lamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

Finally, all dust and debris shall be removed by vacuum-cleaning.

Epoxy primer for galvanised surfaces shall be applied immediately after surface preparation to a minimum dry thickness of 50 µm.

PLQ 3.3 Surface preparation of stainless steel surfaces

Oil and grease contamination shall be removed by:

- Steam-cleaning
- An emulsifiable or aqueous detergent, or
- An alkaline cleaning solution.

Stainless steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive. The use of steel shot and steel or cast iron grit is strictly prohibited.

The grade of cleanliness shall be at least Sa 2½.

Surface profile shall be in the range of 30 to 50 µm.

Where blasting is impractical, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment must be used.

Dust and debris shall be removed by vacuum-cleaning.

PLQ 4 HOT-DIP GALVANIZING

Unless otherwise specified, steel pipes up to 150 mm dia shall be hot-dipped galvanized. Hot-dip galvanizing to be in accordance with SABS 763 – 1988 except that minimum thickness shall be 55 micron. Cut ends and small damaged areas shall be repaired by the application of a zinc-rich epoxy (single pack) to SABS 763 (ZINC GALV 1 – Dulux or POLY GALV – Plascon).

Only heavy duty galvanising will be approved and all items to be provided with a SABS approval certificate.

PLQ 5 EPOXY PAINTS

Epoxy paint shall comply to SABS 1217. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1.

The following will be applicable where epoxy paint is specified:

- Lining of pipes with nominal diameter equal or larger than 600 mm and standard pipe lengths of 9,144 m, 12,192 m and 18,288 m:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Solvent free epoxy (Sigmaline 523 or Pipecoat SF or similar approved by Engineer), with a minimum dry film thickness of 400 micron and a maximum dry film thickness of 500 micron.

- Lining and coating if all other pipes, specials and fittings, except where multi-purpose epoxy coating is specified:

Solvent borne epoxy (Carboguard 891 or Sigmaguard 720 or similar approved by Engineer) with a minimum dry film thickness of 400 micron.

Epoxy paint and the repair kit for the repair of epoxy shall be from the same manufacturer.

Edges with epoxy paint shall have a radius of 3 mm or 50 % of the pipe wall thickness (smaller of two).

Where another type of coating is specified, epoxy paint lining shall continue around pipe edge for each of the following:

- *Flanged end*
Onto both flange faces, extending for 50 mm (min) onto pipe outer wall beyond flange.
- *Ends suitable for straight or stepped couplings or flange adapters*
Onto pipe outer wall for 250 mm (min) from pipe end.
- *Ends suitable for flange adapters, incorporating a restraining flange*
Onto pipe outer wall from pipe end, up to and including both faces of the restraining flange as well as 50 mm (min) beyond the restraining flange.

The following specification shall be applicable to pipes, specials and fittings to be painted with epoxy.

- In the factory:
Abrasive blast cleaning of complete steel surface to Sa 3 of ISO 8501-1. Apply epoxy paint to 100mm from pipe end.
- On site:
Abrasive blast cleaning of steel surface to Sa 3 of ISO 8501-1 and 50 mm of painted surface to a surface profile of 60 – 85 microns.

Apply epoxy repair kit from the same manufacturer as the factory applied epoxy to a minimum dry film thickness of 400 micron. The type of epoxy repair kit shall be subject to the approval of the Engineer.

The painted area shall be tested for pinholes and thickness.

PLQ 6 UV-RESISTANT MULTI-PURPOSE EPOXY PAINT

Multi-purpose epoxy shall be of the high build, modified aluminium epoxy mastic type, containing at least 90% solids.

PLQ 7 RE-COATABLE POLYURETHANE

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The surface shall be vacuum-cleaned to remove dust and debris.

Over-coat with a 40 µm minimum layer of Re-coatable Polyurethane in accordance with the Employer's colour code.

PLQ 8 FUSION BONDED, MEDIUM DENSITY, POLYETHYLENE COATINGS (MDPE)

An uniform MDPE coating must be obtained by dipping the already prepared and heated pipe into a fluidified bed of MDPE powder which then fuses directly on to the heated surface.

A coating thickness of between 1,8 mm to 2,3 mm depending on the outside diameter (OD) of the pipe and the service for which it is required must be obtained with the coating extending around the ends of the pipe to underlap the concrete lining for Sinta Joint pipes by a minimum of 25 mm.

- OD < 508 mm : coating thickness = 1,8mm
- 508 mm ≤ OD ≤ 762 mm : coating thickness = 2,0mm
- OD > 762 mm : coating thickness = 2,3mm

Fusion bonded MDPE coatings shall comply to AS 4321 and must meet the applicable SABS requirements for this type of pipe protection. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1.

PLQ 9 POLYMER MODIFIED BITUMEN (BITUGUARD)

Bitugard coating shall be in accordance with SANS 1178 and BS EN 10300, Type A Heavy Duty with a minimum thickness of 4mm.

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

PLQ 10 THREE LAYER POLYETHYLENE COATING (3LPE)

3LPE coating to be in accordance with CSA Z245.20 - 21 with the following minimum thicknesses:







- Fusion bonded epoxy (FBE) layer: 300 micron
- Adhesive layer: 200 micron
- High density polyethylene layer:
 - Nominal pipe diameter up to and including 250 mm – 2,0 mm
 - Nominal pipe diameter greater than 250 mm but less than 600 mm – 2,5 mm
 - Nominal pipe diameter of 600 mm and greater - 3,0 mm

A polyethylene layer cut back shall be provided at pipe ends as follows:

Pipe ends shall be supplied as bare steel, free of all coating, for a distance of 100 mm (+25/-0mm) from the pipe end. In addition, each pipe end shall be left without polyethylene / adhesive coating so that a 20 mm (+10/-0mm) FBE toe protrudes on the steel beyond the cutback polyethylene coating layer.

The ends of the coating shall be bevelled at 30° to 45°.

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

After blast cleaning and prior to the application of the FBE layer, the pipe surface shall be pre-treated by acid wash. A method statement for the acid wash supported by product data and the PQT results shall be provided for the review of the Engineer before commencement of the coating process.

PLQ 11 JOINT COATING SYSTEMS

PLQ 11.1 MDPE and three layer polyethylene (3LPE) coating

The unprotected area at welded joints shall be protected as follows:

- The cutback of the coating shall be 100 mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- The factory applied polyethylene pipe surface to which the cold tape wrapping is to be applied shall be abraded with 40 grit abrasive paper or sweep blasted for 100mm beyond the steel surface toe.
- Abrasive blast clean the steel surface to Sa 3 of ISO 8501-1.
- For 3LPE apply Denso Protal 7200 liquid epoxy to the blast cleaned surface and adjacent prepared factory FBE coating to a minimum dry film thickness of 400 micron.
- The entire joint surface to be wrapped shall be primed with Denso Primer D.

Priming shall not be carried out further ahead of physical tape wrapping than a maximum of 4 hours.

Ensure the primer is dust free prior to application of a tape wrap system. If the primer has become severely contaminated with dust, a re-prime shall be carried out. Heavy contamination with sand or dirt shall require cleaning of the surface with a manufacturer recommended cleaning solvent (e.g. Denso Cleaning Solvent) and re-application of the primer.

Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

- The inner wrap shall consist of a 100 mm wide conformable polyethylene backed modified bitumen mastic tape, compliant with the requirements of SANS 1117 type C (DENSO ULTRAFLEX 1250/300)

Peel back approx. 0,5 m of interleaving. Align the edge of the 100 mm wide tape 50 mm onto the primed, factory applied, polyethylene pipe coating. Press down firmly.

Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm.

Whilst maintaining tape tension as described above, the tape shall be applied spirally. Remove interleaving as wrapping proceeds.

The tape shall be applied to ensure that a minimum 25 mm overlap shall be achieved.

- The outer wrap shall consist of a 100 mm wide medium density adhesive polyethylene compliant with the requirements of SANS 1117 Type B&D (DENSO MDP 032).

Centre 100 mm wide outer-wrap tape on the edge of the applied inner wrap tape on the factory applied coating. Press down firmly. Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of

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tape between 1 and 2 mm. Whilst maintaining tape tension as described above, the tape shall be applied spirally.

The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

The tape shall be applied to a minimum width of 50 mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

- Holiday detection shall be carried out in accordance with NACE RP0188.

Damaged areas on MDPE coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer.

PLQ 11.2 Polymer Modified Bitumen (Bituguard) Coating

The unprotected area at welded joints to be coated with Denso Primer D and wrapped with Densotherm HD heat applied bitumen wrapping with a minimum thickness of 5 mm.

Surface preparation shall be abrasive blast cleaned to Sa3 of ISO 8501-1.

PLQ 12 DENSO HT PETROLATUM TAPE WRAPPING SYSTEM

Denso HT Petrolatum tape wrapping system shall be used for the wrapping of buried flange and flexible joints and buried galvanized pipes and where specified in the Specifications, Bill of Quantities or Drawings.

PLQ 12.1 General

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

Chamfer any raised edges or steps in the existing coating.

Apply Denso Priming Solution.

Apply Denso HT Tape of appropriate width uniformly in a spiral fashion to give a 55% overlap on the pipe and for not less than 200 mm along the length of the intact factory coating.

Apply uniform tension to ensure the tape is smooth and free from wrinkles. Do not apply excessive tension that will stretch the tape nor insufficient or uneven tension that will give rise to air bubbles and wrinkles.

PLQ 12.2 Flexible couplings and flanges

Apply Denso Mastic so as to create a smooth profile suitable for over-wrapping. Wrap a suitable width of Denso HT Tape over the coupling. Ensure that there are not air voids under the tape. Apply a double layer of Denso Layflat polyethylene sheeting over the whole length of the repair and for 100mm beyond each end of the repair. Tape the ends of the Layflat with two complete turns of 100 mm wide adhesive Denso PVC tape to seal the ends.

Denso fabric backed mastic blanket can be used as an alternative for Denso HT Tape. After priming, pack potential air void areas such as under the bolts with Denso Mastic. Place the mastic Blanket in position and press it into all air voids. Start under the pipe and work upwards. Over wrap the Mastic Blanket with two layers of Denso Layflat sheeting and secure the ends with 100mm wide adhesive Denso PVC tape.

If the pipe runs through very wet soils it is recommended that Denso S105 Paste be used in preference to Denso Priming Solution and the couplings be wrapped with Denso PVC Self Adhesive Tape using a 55% overlap in place of the Layflat Sheeting.

PLQ 12.3 Welded joints and straight pipe lengths

After completion of Denso HT Tape wrapping and approval by the Engineer, apply 0,3mm adhesive PVC outerwrap with 55% overlap over the whole length of the wrapping and for 100mm beyond each end.

PLQ 13 CUT BACK AT PIPE ENDS

The exposed grit blasted bare steel surface at the ends of pipes, specials and fittings to be welded on site shall not be painted with any product in the factory and shall be protected against corrosion after installation.

PLQ 14 ADDITIONAL EXTERNAL PROTECTION FOR PIPES CAST INTO CHAMBER WALLS

After the concrete has cured for 7 days, wire brush or scabble the exterior and interior surfaces of the wall to remove laitance. Dry brush to remove all loose powder.

Mix ABE Super Laykold and water (1:1 ratio) and apply as a primer to the concrete and the pipe surfaces. After 1 hour apply a thick coat of ABE Super Laykold to the concrete and the pipe and immediately embed 250mm wide ABE non-woven polyester membrane "SBP" into the Super Laykold. After 3 hours apply another coat of Super Laykold.

This additional protection is required on the inside and outside of chamber walls.

There must be no contact between the steel pipe and the chamber reinforcement.

PLQ 15 MEASUREMENT AND PAYMENT

Corrosion protection and painting shall not be measured separately. The price for corrosion protection and painting shall be deemed to be included in the price for the pipe, fitting or special.

RUSTENBURG WATER SERVICES TRUST

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RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

PLN: MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

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PLN MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

PLN 1 SCOPE

This specification covers the manufacture and supply of bare, electric welded low carbon steel pipes and steel pipe special items for the conveyance of water at ambient temperatures and at medium pressures.

PLN 2 STANDARDS

Pipes and specials shall be manufactured, tested and inspected in accordance with the latest issues of the following standard specifications unless amended in subsequent clauses in this specification.

a) Pipes

SABS 719 : Steel Grades A, B and C
SABS 1431 : Steel Grades 300 WA
API 5L : Steel Grades, X42, X46, X52, X56 and X60

b) Specials

- Specials of 150 mm nominal diameters and smaller to be manufactured with pipe conforming to SABS 62 (heavy duty) or ASTM Schedule 40 to suit specified pressures.
- Specials larger than 150 mm nominal diameter shall be manufactured from pipes complying with this specification.
- The radiographic technique, adjudication of radiographs and repair of defects shall be in accordance with API 1104.

c) Qualifications of Welders

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified under the tests laid down in accordance with API 1104.

d) Non-destructive Tests and Adjudication

- Radiographic inspection: API 1104
- Ultrasonic inspection: API 5L

e) In this Specification reference is made to the latest issues of the following specifications:

SABS 719
API 5L
API 1104
ASME Section V
BS 2971
BS 2633

PLN 3 STRESSES

- #### **a)**
- All pipes shall be hydrostatically tested as described in PLN 6.5 to a pressure such as to produce a circumferential tensile stress in the steel of not less than 85% of the minimum yield stress.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- b) The design stress for pipes subjected to the specified design pressures shall be 60% of the minimum yield stress of the steel.

PLN 4 PROCESS OF MANUFACTURE FOR PIPES

PLN 4.1 Pipes shall be manufactured by an approved semi automatic submerged-arc welding process or shall be electric resistance welded. Where semi automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. The number of longitudinal weld seams shall not exceed:

- a) one seam for pipes up to 1 000mm nominal diameter
b) two seams for pipes larger than 1 000mm and up to 2 000mm nominal diameter

Circumferential welds by semi automatic submerged-arc welding method for factory double jointed pipes shall have at least one pass on the inside and at least one pass on the outside.

PLN 4.2 Welds

SABS 719, BS 2971 and BS 2633 shall generally apply.

For fusion welded pipes and specials, the internal weld bead shall not protrude more than 1mm into the bore of the pipe or special.

For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 1,0mm.

For pipes to be jointed by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200mm from ends to be jointed.

For pipes to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 200mm from the end to be coupled.

PLN 5 DIMENSIONAL REQUIREMENTS

PLN 5.1 Pipes

All dimensions will be in accordance with SABS 719 clause 4.

PLN 5.2 Specials

The tolerances on specials will be in accordance with BS 534, Section 4.

Unless shown otherwise, branch and manifold sections of Tees to have a common centre line and of Scour Tees to have a common invert line.

All dimensions on layout dwgs or item details are outer face to outer face, i.e. overall.

Position dimensions for puddle flanges and restraining flange refers to centre of flanges.

PLN 6 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND AT SITE

PLN 6.1 General

Factory and Site inspection, supervision of tests and adjudication of test records shall be carried out by an independent Inspectorate.

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Witness 1

Witness 2

Employer

Witness 1

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June 2025

All tests and inspections at the factory and on site shall be at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that might be required, free of charge.

The Inspectorate shall be afforded every facility during the course of manufacture and testing to enable the inspection to be carried out effectively.

All test samples shall be selected by the appointed Inspectors and all instruments used for testing purposes shall be approved by the Inspectors and if in the opinion of the Inspectors any instrument should require calibration, such instruments shall be calibrated at the expense of the Contractor by the SABS or such other body as may be approved by the Inspectorate.

No mechanical working or straining of pipes and specials shall be allowed after testing and inspection.

PLN 6.2 Visual Inspection

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L Section 10.7.

PLN 6.3 Non-destructive Inspection

PLN 6.3.1 Ultrasonic Inspection

Pipes shall be made by an approved welding process and 100 percent of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L Section 9.10, 9.11 and 9.12 except that the equipment shall be checked with an applicable reference standard at least twice every working run.

PLN 6.3.2 Radiographic Inspection

a) Longitudinal Weld Pipe

All electric fusion welded pipes, shall be inspected by radiological methods for a distance of 200 mm from each pipe end.

b) Spiral Weld Pipe

All electric fusion welded pipes shall be inspected by radiological methods for a distance of 100 mm from each end of each length of pipe and of the complete "H" at all scalp and welds including 150 mm of the spiral welds in both directions away from the intersection points with the scalp and welds.

c) Circumferential Butt Welds

100 percent of the length of circumferential butt welds shall be examined unless consistently acceptable results are obtained. Then the number of welds so to be tested may be reduced by mutual agreement between the Engineer, the Inspectorate and the Contractor.

d) Specials

100 percent of all manual or semi-automatic welds in specials shall be examined radiographically unless consistently acceptable results are obtained. Then the number of welds so to be tested may be reduced.

Where specials cannot be hydrostatically tested, all welds shall be liquid penetrate tested as per ASME Section V.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

e) Repairs

Straight Piping :

100 percent of the total length of all repairs shall be examined radiographically unless repairs are done prior to ultrasonic inspection and such repairs pass ultrasonic inspection. Then no radiographic inspection of same is required.

f) Pipes for Rail, Road and River Crossings: 100 percent of the total length of all welds shall be examined radiographically.

PLN 6.4 Hydrostatic Testing

- a) Each individual straight pipe shall be subjected to a hydrostatic test in accordance with the methods described in API 5L, Section 5. Test pressures shall be such as to produce tensile fibre stresses in the pipe wall of not less than 85% of the minimum specified yield strength of the steel or shall be 9 MPa whichever is the lesser. Leaks or sweats shall be considered injurious defects.
- b) Should it not be possible to hydrostatically test straight piping and/or specials the through liquid penetrate test as per ASME Section V shall be done on all welds over and above the non-destructive tests specified above. This shall only be applicable with the prior written approval of the Engineer.

PLN 6.5 Repair of Injurious Defects

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L, Section 10.7 shall be repaired in accordance with API 5L Section 10.8 and 10.9 but subject always to the requirements of this specification.

PLN 6.6 Destructive Testing

PLN 6.6.1 The following destructive tests shall be performed in accordance with SABS 719 clause 7.2 on the first pipe and thereafter on one pipe of each 500 subsequent pipes.

- a) Transverse Tensile Test
b) Root Bent Test (Electric Fusion Welds)
c) Flattening Test (Electric Resistance Welds)

PLN 6.6.2 Sampling for Destructive Tests

a) **First Sample**

A section long enough to provide all the test specimens and material shall be cut from the selected pipe.

b) **Second Sample**

If the test specimens and material from the first selected pipe fail to pass any of the tests, a section long enough to provide the appropriate specimens for the tests failed by the first sample shall be cut from two further pipes.

c) **Third Sample**

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

If the test specimen from the second sample fails to pass the test(s) a similar section shall be cut from each of a further ten pipes.

d) **Compliance**

The piping shall be considered as complying with the specification if after testing of the first or the second or the third sample no defect is found.

PLN 7 FLANGES

- a) Material shall be steel plates to conform to the requirements of SABS 1123 (1977), unless otherwise specified.
- b) Dimensions and drilling shall be in accordance with SABS 1123 (1977) unless otherwise specified. Flanges for 64 bar working pressure shall be in accordance with BS4504:1969. Dimensions not covered by SABS 1123 and BS4504, shall be in accordance with NWS 1676 Revision 0.
- c) All flanges shall be of the steel-plate for welding type and shall have flat joint faces unless otherwise specified.
- d) Connecting surfaces shall be in accordance with SABS 1123 clause 4.5.
- e) Puddle flanges need not be drilled. Where puddle flanges are slanted to an item, special flanges are required. Such flanges need not be circular, but shall meet the specified pressure rating and must protrude at least 100 mm outside item outer wall.
- f) Provide appropriate bolt units, consisting of a standard length bolt, nut and two washers of a material to conform to the requirements of SABS 1123 where applicable, otherwise to the requirements of the Engineer for each set of flanges and for flange adaptor to flange installations.

NB: The shortest standard bolt or stud that protrudes beyond the nut by a minimum of two threads, when the assemblies are fully tightened, shall be used. A washer shall be fitted under all bolt/screw heads and nuts.

- g) Gaskets for flanged connections shall be of aramid and glass fibre with nitrile rubber binder to BS 7531, ring type with a minimum thickness of 3 mm, unless otherwise specified.
- h) Should certain equipment e.g. valves, etc. only be supplied with specific flange drilling, the Contractor must arrange for adjacent flanged items to have the same drilling prior to the manufacture of such items.
- i) Some flexible couplings to be restrained by means of a restraining flange. The diameter, number and length of the long restraining bolts as well as any possible pipe wall thickening to be designed by manufacturer for specified pressures. The seal retaining flange on the flexible coupling may be factory machine scalloped to accommodate the long bolts. Provide all the necessary nuts, washers, etc. for the restraining bolts.

Restraining flanges need not have all the bolt holes specified in the applicable flange drilling table. Only those required for the long restraining bolts need to be provided; these holes should, however, comply with the applicable flange drilling table and be spaced equally on the flange PCD and symmetrically around the flange centre lines.

Restraining bolts to be positioned so as to not clash with any stubs specified for an item.

- j) Blank flanges for pipes equal to or greater than 400 dia to be provided with two approved lifting handles.

PLN 8 FLEXIBLE COUPLINGS AND FLANGE ADAPTORS

Flexible couplings and flange adaptors shall be the Viking Johnson or Klamflex type.

Manufacture of straight and stepped couplings (SR-C + ST-C) as well as flange adaptors (FA) to be approved by Engineer. Couplings must be able to withstand hydrostatic test pressures of 1.5 times the specified design pressures and coupling flanges must be designed to withstand all stresses due to tightening of the bolts. Rubber rings shall generally comply to SABS 974 Class F. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

Coupling installation gaps to be to approved supplier's specification.

Applicable to all flange adaptors:

- Studs may not be welded onto flange.
- Flange to be drilled and tapped for threaded studs where applicable.
- Drilling to suit connecting flange.

PLN 9 MARKING OF PIPES

All pipes and specials shall be clearly hand stamped alongside a longitudinal or spiral weld on one end of the pipe with the following.

- a) Grade and thickness of steel
- b) Serial number of the pipe or specials
- c) Nominal diameter
- d) Hydraulic test pressure

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PLK : MANUFACTURE AND SUPPLY OF VALVES

INDEX

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PLK MANUFACTURE AND SUPPLY OF VALVES

PLK 1 SCOPE

This section of the Specification includes the manufacture, testing and supply of valves for the conveyance of raw or potable water at ambient temperatures in pipes under pressure.

PLK 2 STANDARDS

The most recent issues of the following standard specifications will apply for the purposes of this Specification.

SANS 144	:	Cast-iron single door non-return valves
SANS 191	:	Cast steel gate valves
SANS 192	:	Cast steel single door non-return valves
SANS 664	:	Cast iron gate valves for waterworks
SANS 665	:	Cast iron gate valves for general purposes
BS 5155	:	Cast iron and carbon steel Butterfly valves
ISO 2441	:	Pipeline flanges for general use - shapes and dimensions of pressure tight surfaces
SANS 1123	:	Steel pipe flanges
SIS 05 5900	:	Pictorial surface preparation standard for painting steel surfaces

PLK 3 MATERIALS

PLK 3.1 Sluice Valves

PLK 3.1.1 The valve body, bonnet, thrust dome, gate and glands shall be of cast iron or cast steel as specified and depending on the required test pressures.

PLK 3.1.2 The stuffing box shall be of ample depth to afford sufficient space for long period packing and the design shall be such as to allow the gland to be easily and conveniently repacked under pressure.

PLK 3.1.3 Body and gate sealing rings shall be of bronze, gunmetal or stainless steel. RSV gate shall be nitrile rubber covered, and fully encapsulated. The rubber shall not be removed from the guides of the gate.

PLK 3.1.3 Spindles shall be of high grade stainless steel.

PLK 3.1.4 An isolating valve must be able to check the specified water pressure from both sides.

PLK 3.2 Butterfly Valves

PLK 3.2.1 Valve bodies and discs shall be of high-grade cast-iron or cast steel as specified and depending on the required test pressures.

PLK 3.2.2 The disc shaft or stub-shafts shall be of stainless steel located in self-lubricating bearings.

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PLK 3.2.3 Sealing rings, seal retaining rings, body seatrings and associated screws shall be of stainless steel.

PLK 3.2.4 A butterfly valve must be able to check the specified water pressure from both sides.

PLK 3.3 Reflux Valves

PLK 3.3.1 Valve bodies shall be of cast iron or cast steel depending on the specification or test pressures.

PLK 3.3.2 Valve doors shall be of cast iron or cast steel.

PLK 3.3.3 The valve body and doors or disc shall be fitted with replaceable stainless steel body and door seat rings.

PLK 3.4 Air Valves

PLK 3.4.1 Function

Air valves are required to perform any combination of the following functions:

- Uninterrupted high volume air discharge through a large orifice during pipe filling.
- Uninterrupted high volume air intake through a large orifice during pipe emptying.
- Discharge of pressurised air through a small orifice during normal operation.
- Surge alleviation mechanism during rapid air discharge or rejoining of separated water columns.

PLK 3.4.2 Closing mechanism, construction and design

PLK 3.4.2.1 The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. Floats of spherical design shall not be accepted. Any hollow float design will not be acceptable due to implosion and distortion making sealing difficult or impossible.

PLK 3.4.2.2 The ends of the cylinder shall be of fusion bonded epoxy powder coated mild steel, secured by means of stainless steel tie rods.

PLK 3.4.2.3 Floats shall be housed in a tubular stainless steel or corrosion protected body, secured by means of stainless steel fasteners.

PLK 3.4.2.4 The seats, spindles, guides, etc shall be of a suitable non-corroding metal with sufficient clearance and shall be designed to prevent abrasion of the ball or float when subjected to frequent operation.

PLK 3.4.2.5 The seats of the orifices shall not have sharp edges and shall be designed so as not to damage the ball or float when subjected to pressure.

PLK 3.4.2.6 The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns.

The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure.

Relief mechanisms that act subsequent to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.

The performance capability of an integral surge alleviation mechanism shall be substantiated through third party testing, conducted by a recognized authority.

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Employer

Witness 1

Witness 2

PLK 3.4.2.7 Large orifice sealing shall be effected by the flat force of the control float seating against a nitrile rubber 'O' Ring housed in a dovetail groove circumferentially surrounding the large orifice.

Sealing in any other form shall not be accepted due to the vulcanizing of the float or the wedging of the float in the large orifice.

PLK 3.4.2.8 Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

Valves with slotted air release apertures shall not be considered.

PLK 3.4.2.9 The intake/discharge orifice area shall be equal to the nominal size of the valve i.e. a 200 mm valve shall have a 200 mm intake/discharge orifice.

Valves up to and including 200mm NB shall incorporate an over pressure safety feature that will fail without an explosive effect, such as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

PLK 3.4.2.10 The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to 2 times the designed working pressure.

PLK 3.4.3 Testing

PLK 3.4.3.1 Manufacturers' published performance data must be substantiated by third party testing from a recognized test authority.

PLK 3.4.3.2 A high pressure strength and leak test whereby the valve is filled with water and pressurized to 2 times the rated working pressure which shall be held for a period of 2 minutes. Any leaking, weeping and sweating shall be a reason for rejection. These tests must be on total, completed units including floats.

PLK 3.4.3.3 Any imported valves shall be retested locally in all areas of specification.

PLK 3.4.4 Isolating valves for air valves

PLK 3.4.4.1 Each air valve shall be provided with a suitable double flanged resilient seal gate valve to isolate the air valve from the main.

PLK 3.4.4.2 The isolating valves shall be capable of operating in a horizontal position and shall be provided with a handwheel for operation and gearing is not required.

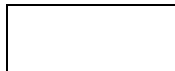
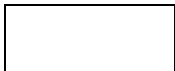
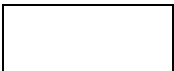
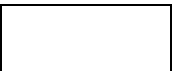
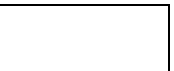
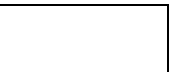
PLK 3.4.4.3 Each isolating valve shall be provided with a handwheel fitted to the spindle in an approved manner and shall have directional indication so cast into a recess on the upper surface of the rim that the top of the letter, arrows and rim are at the same level.

PLK 3.4.5 Drains

PLK 3.4.5.1 All air valves be provided with drain cocks so that the body of the valve can be drained when isolated from the pipeline. Cast steel gate valves shall be provided for this purpose.

PLK 3.4.6 Pressure gauge fitting

PLK 3.4.6.1 A 12-mm cast steel full bore gate valve shall be fitted to the spool piece between the isolating valve and the air valve flanges for attaching a pressure gauge.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PLK 3.5 Ring needle valves

- PLK 3.5.1 The valve body shall be of spheroidal graphite iron or cast-steel with supporting feet. The body seat shall be of stainless steel and shall be replaceable or may be deposit welded on a removable body section.
- PLK 3.5.2 For ring needle valves the piston (plunger) shall be of cast stainless steel with replaceable resilient seal to obtain drop tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws.
- PLK 3.5.3 For spherical ball valves, the eccentrically supported ball plug shall be of cast stainless steel or spheroidal graphite iron with replaceable resilient seal to obtain drop-tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws. The valve body shall include an access door to permit adjustment or replacement of the valve seal without dismantling the valve.

PLK 3.6 Manufacture

PLK 3.6.1 General

- PLK 3.6.1.1 The design pressure of the valves shall not be less than the pressure specified subject to a minimum of 1 000 kPa.
- PLK 3.6.1.2 All valves shall be double-flanged with bolt holes drilled off-centre all in accordance with the requirements of SANS 1123 or as otherwise specified.
- PLK 3.6.1.3 The Tenderer shall give as a function of the downstream pressure the maximum acceptable discharge of water through the valves without risks of vibration and cavitation. The Tenderer shall also submit the head-loss characteristics of the valves.
- PLK 3.6.1.4 The design pressure will be hand stamped on the top edge of the flanges of valves in kPa.
- PLK 3.6.1.5 If specified, valves shall be supplied with by-passes to be bolted on to the body of the valve and not to the adjoining pipework.
- PLK 3.6.1.6 Valves shall be fitted with position indicators if specified. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators.
- PLK 3.6.1.7 Arrows shall be cast on all handwheels together with the wording "OPEN" or "CLOSE". The closing direction shall be clockwise unless otherwise specified.
- In the case of cap top valves, an aluminium disc of at least 100 mm diameter and with the same wording and arrows shall be slipped over the spindle and retained by the cap.
- PLK 3.6.1.8 All valves shall be supplied complete including bolts, nuts, washers and gaskets in accordance with the class of valve. Bolts shall be of sufficient length to allow not more than three screw threads to protrude outside units after complete tightening of the assembly. Gaskets for flanged joints shall be of compressed asbestos fibre to BS 2815 Grade A and full faced with a minimum thickness of 3 mm for pressures up to and including 1 600 kPa cloth-inserted rubber may be used.
- PLK 3.6.1.9 Where isolating valves are required to be equipped with extended off-set spindles, the spindles shall be equipped with sufficient universal joints to ensure satisfactory valve operation. All spindle extensions shall be secured to permanent structures with galvanised clamps to the Engineer's approval. The rate for such valve items shall include for any required clamps, extensions joint, etc.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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Handwheels on such extended spindles shall be mounted on plain-ended spindle or handwheel pedestal as specified or indicated on the construction drawings.

Isolating valve operation:

Cap top	CT
Handwheel	HW
Electric actuator	EA
Pneumatic actuator	PA
Handwheel spindle extension	HSE
Plain ended spindle extension	PESE
Platform-mounted handwheel pedestal	PMP
Handwheel pedestal on wall support bracket	HPWB
Stub handwheel pedestal on wall support bracket	SHWB
Grid-mounted handwheel pedestal	GMP

PLK 3.6.1.10 The following information shall accompany the tender:

- Description
- Flange Drilling
- Maximum working pressure
- Maximum unbalanced pressure
- Test pressure
- Manufacturers number
- Material of components
- Gearing
- Accessories

PLK 3.6.2 **Sluice Valves**

PLK 3.6.2.1 Double-flanged, wedge-gate, internal (non-rising) spindle sluice valves of the waterworks pattern are required to comply fully with SANS 191 or SANS 664 where applicable.

PLK 3.6.2.2 Only full-way valves will be accepted (i.e. the gate must be clear of the waterway in the fully open position).

PLK 3.6.2.3 The maximum force required to turn the handwheel at the maximum torque shall not be greater than 100 N per hand at the handwheel run (Total effort = 200 N) when operating at an unbalanced pressure equal to the rated working pressure of the valve. This may be achieved with the aid of gearing of a suitable ratio.

Where gears are used replaceable shear pins shall be provided to prevent damage to the valve if excessive pressure is used.

PLK 3.6.3 **Butterfly Valves**

PLK 3.6.3.1 Horizontal spindle type butterfly valves complete with gearing, handwheels and flanged at both ends with separate bolting for joining to the adjacent pipework is required.

PLK 3.6.3.2 Wafer valves or valves fitted with studs for attachment to the adjacent flanges are not permitted.

PLK 3.6.3.3 Valves shall be drop-tight when closed and metal to metal sealing is not acceptable.

PLK 3.6.3.4 All resilient seals shall be removable and readily replaceable on Site with the valve in position.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PLK 3.6.3.5 Resilient seals shall be retained by corrosion resistant securing elements to prevent corroding in position (e.g. bolts, set screws, etc.)

PLK 3.6.3.6 The valve-water seal shall be of the following types:

- a resilient seal fixed to the edge of the disc by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the body.
- a resilient seal fixed to the body of the valve by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the edge of the discs.

PLK 3.6.4 *Reflux Valves*

PLK 3.6.4.1 Reflux valves shall be double-flanged, SANS 1551.
PLK 3.6.4.2 Valve bodies and seals shall be free of pockets that will allow dirt accumulation and prevent the doors from closing fully.

PLK 3.6.4.3 Stops or an approved resilient material shall be fitted into the body to prevent the doors from fluttering under full flow conditions.

PLK 3.6.4.4 Valves shall be designed to allow for rapid but non-slamming closing characteristics.

PLK 3.6.5 *Air Valves*

PLK 3.6.5.1 Air valves shall be supplied with double-flanged, wedgeway internal (non-rising) spindle sluice valves for isolation, which unless otherwise specified shall conform in all respects to this specification.

PLK 3.6.6 *Ring needle valves*

PLK 3.6.6.1 Ring needle valves used as auto closing valves shall fulfil the following functions:

- Electrical operation (isolating and control) suitable for opening and closing against the specified pressure and for continuous operation in any intermediate position.
- Automatic as well as manual mode control.
- Automatic reflux action for quick closure by means of drop-weight and hydraulic dash pot in case of power failure or motor protective tripping.
- Adjustable closing time and adjustable closing characteristic.

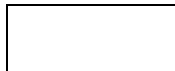
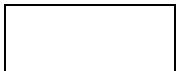
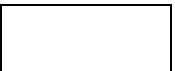
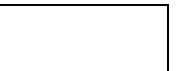
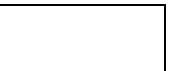
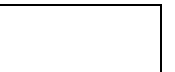
PLK 3.6.6.2 The totally enclosed flanged-on gearbox shall include the following:

- Either an electro-mechanical unit comprising:
 - a totally enclosed brushless electromagnetic gear clutch for quick closing;
 - a totally enclosed directly mounted electric valve actuator with integral electric controls and auxiliary handwheel for manual operation;
- or an electro-hydraulic unit comprising:
 - an oil hydraulic lift cylinder for opening the valve;
 - a totally enclosed directly mounted electronic driven oil pump and oil reservoir. The oil pump and reservoir may be individually mounted on each valve or a centralised system may be employed to feed more than one valve and/or pumpline;
 - a solenoid operated hydraulic control valve which shall be de-energised to initiate closure of the valve.

- PLK 3.6.6.3 Either of the above actuators shall also be provided with:
- limit switches for signalling the “open”, “closed” and intermediate “10%” positions and further control functions as required;
 - a directly mounted oil hydraulic dashpot with the necessary control valves for adjusting closing time and operating characteristic;
 - means to operate the valve manually;
 - valve shaft (stub shafts) of high tensile stainless steel located in bushes of zinc-free bronze;
 - a drop weight lever arm of steel with adjustable cast iron drop weight. The lever arm shall be keyed or splined to the shaft.
- PLK 3.6.6.4 The overhang shaft carrying the drop weight lever arm shall be supported at its bearing housing from the foundation block.
- PLK 3.6.6.5 Travel of the drop weight shall be restrained for reasons of safety at either end of the lever arm.
- PLK 3.6.6.6 The control valves shall be arranged for selection of either manual-electric or automatic-electric operation controlled from the pump control console. Push buttons “open”, “close” and “stop” for piloting these valves, when throttling is required, shall be incorporated in each pump control console, as well as indicator lamps showing “closed” (green) “intermediate” (amber) “open” (red) positions. In addition, a selector switch “manual/automatic” shall be incorporated, the automatic position being in conjunction with pump starting. A further “test” selector switch shall be mounted inside the panel to permit manual-electric testing of the equipment without running the pumpset.
- PLK 3.6.6.7 In the “automatic” mode the valve shall open automatically from the fully closed to fully open position when the pumpset is started, likewise closing automatically, when the pumpset is to be shut down. In the “manual” mode the valve shall open automatically to at least the “10% open” intermediate position, whereafter manual selection of the valve position shall be enabled.
- Each valve shall be interlocked with the pump starter. When the pump is to be stopped, the valve shall close slowly to prevent water hammer either by means of the electric actuator or by releasing hydraulic pressure in the lift cylinder by means of control valves before the pumpset is tripped and stopped by interlocked relays.
 - Similarly, the valve shall be arranged so that the pump can be started only when the valve is fully closed. The valve shall open only when the starting operation is completed and the motor is up to speed.
- PLK 3.6.6.8 The control valves shall have automatic reflux action features to close by drop-weight, controlled by an oil hydraulic dashpot, in the event of power failure or motor protective tripping. The drop-weight shall be released by a solenoid operated clutch or a valve which is constantly energised during pumping operations. Closing time and characteristics shall be adjustable to minimise water hammer.
- PLK 3.6.6.9 It shall be possible to energise the “manual” mode only when:
- the associated pump is running.
 - the valve is at least 10% open as indicated by the “intermediate” lamp.
 - the valve is in the “test” mode

Selection of the “manual” mode shall not affect the automatic reflux action.

When the opening of the valve has been set manually, the valve shall maintain this position in the absence of any further action.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PLK 3.6.6.10 "Test" mode: With both isolating valves closed and electrically interlocked, a test facility shall be provided to enable the maintenance personnel to manually operate the valve without the pumpset running by selection from inside the pump control console.

PLK 3.6.6.11 Valves shall be designed to operate free of cavitation in intermediate positions.

PLK 3.6.7 *Electric Actuators*

PLK 3.6.7.1 When specified, in the Project Specification the valves shall be fitted with electric, motor-driven flood-proof IP 68 actuators of robust design, capable of closing the valves under all unbalanced pressures.

PLK 3.6.7.2 The Tenderer shall state the maximum torque required to operate the valve in his Tender. In determining this maximum torque an allowance shall be made for any deterioration that could be expected to occur in the bearings during the life of the valve. The actuator shall be capable of transmitting twice this maximum torque without any of its components suffering permanent damage. This shall be proven to the Engineer's satisfaction by workshop tests.

PLK 3.6.7.3 The actuators shall be capable of restraining the valve in any position under all possible conditions of operation, and shall not, in any circumstances, be capable of becoming self-motorised as a result of the dynamic torque loading on the disc or plunger.

PLK 3.6.7.4 All gearing shall be manufactured in accordance with BS 436 Class C and shall be machine cut. All components requiring lubrication shall be adequately lubricated and totally enclosed flood-proof casing fabricated in cast iron and/or die cast aluminium to suit the service weather proof casing whether the valve is to be installed in the open or under cover. Actuators shall also be fitted with mechanical stops to prevent excessive turning and shall be provided with replaceable shear pins.

PLK 3.6.7.5 Handwheels shall be fitted to all actuators. The direction of rotation to close the valve shall be clockwise when viewed from above the end of the input shaft and from the position of operation. In addition, they shall be clearly and indelibly marked with an arrow showing the direction of closing and the words "Close" and "Toe".

PLK 3.6.7.6 Whether the valve is actuator driven or manually operated, the maximum force required to turn the handwheel at the maximum torque defined above shall not be greater than 100 N per hand at the handwheel rim. (Total effort = 200 N.) For large valves the minimum of complete revolutions of the handwheel to move the valve gate from fully open to fully closed shall not be less than 100.

PLK 3.6.7.7 All electric actuators shall be provided with reversing contactors: local and remote control shall be provided; a device making the local control non-operative shall also be provided on the relevant remote control panel.

PLK 3.6.7.8 After factory tests, the actuators shall be removed from the valve and delivered to Site in separate boxes to safeguard against damage.

PLK 3.6.8 *Protection*

PLK 3.6.8.1 All materials and workmanship to comply with relevant SANS specifications.
Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 50 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP 2300 or similar) shall then be applied to give a final dry film thickness

of 250 µm. Drying times between successive layers shall be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solventless epoxy paint system or a fusion bonded epoxy powder coating as specified in the Project Specification.

PLK 3.6.8.2 External Protection

External surfaces of valve bodies shall be wire brushed to a A 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer (dried film thickness 50 µm). This will be followed by two alkyd-based undercoats (each coat 25 µm thick) and one alkyd-based enamel finishing coat (dried film thickness 25 µm). Final colour will be as specified by the Engineer.

Machined flanges will be painted with a protective coating of shellac or similar.

PLK 3.7 Tolerances

Tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

PLK 4 TESTING AND INSPECTION

PLK 4.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SABS or BS Specification. These tests will not necessarily be attended by the Engineer but records must be kept and all test results shall be made available to the Engineer.

PLK 4.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. Samples required for such tests will be provided by the Manufacturer free of charge and sampling will be done by this body in accordance with the relevant SANS or BS Specification.

The cost of such control tests will be borne by the Employer.

PLK 4.3 Inspection

PLK 4.3.1 Visual, operational and dimensional inspection of valves as well as inspection of protective coatings will be carried out by the Engineer and/or the Manufacturer in the Manufacturers workshops prior to the despatch of valves to site.

PLK 4.3.2 Inspection by the Engineer shall in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

PLK 4.4 Hydrostatic Testing

PLK 4.4.1 All hydrostatic tests will be witnessed by the Engineer and the Manufacturer will give at least one week prior notification to the Engineer of the proposed dates for such tests.

PLK 4.4.2 Valve bodies will be close end tested to at least 1,5 times the working pressure. Test pressures will be maintained for at least 5 minutes and valve bodies will be water tight in all respects at the test pressure.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PLK 4.4.3 Assembled valves will be open-end tested to 1,5 x working pressure for materials strength and soundness. Valves will be drop tight from both directions over the complete range of pressures from 0 to 1,5 x working pressure.

PLK 4.4.4 Each valve will be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

PLK 5 MEASUREMENT AND PAYMENT

PLK 5.1 General

Tendered prices shall include for the following unless otherwise specified in the Project Specification.

- Protective coatings as specified.
- Couplings and/or jointing material for each type of valve.
- Packing and temporary protection against damage during transport and delivery.
- Temporary storage and maintenance if required.
- Delivery and storage of material on site or in a store as specified.
- Testing and inspections at Manufacturer's works.

PLK 5.2 Valves will be measured per unit of each type

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PLT: FLOW METERS (GENERAL)

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PLT FLOW METERS

PLT 1 SCOPE

This section of the Specification deals with the supply, delivery, installation and commissioning of:

- (a) in line ultrasonic flow meters;
- (b) clamp on ultrasonic flow meters
- (c) flanged mechanical turbine meters
- (d) electromagnetic flow meters.

PLT 2 IN-LINE ULTRASONIC FLOW METERS

PLT 2.1 General Requirements

An in-line ultrasonic flow meter will consist of:

- i) Two machined, stainless steel, weld-on sockets with inserted perspex windows, which are held by two plastic flanges secured with stainless steel bolts and spring washers.

The tenderer shall be responsible for the welding of the sockets on to the pipeline, as well as making good all corrosion protection according to applicable specifications.

- ii) Two 1 MHz sensing units, connected via co-axial cables of 50 ohms, with a minimum length of 12 m, to the transmitter.

The sensing units are to be removable under full pressure, while the pipeline is operating.

Both sensing units shall be electrically isolated from the pipeline.

- i) A transmitter that shall have two output circuits:
 - (1) One circuit for the 4-20 mA output signal to drive an indicator, and if later required a recorder, with maximum load capacity of 1 000 ohm.
 - (2) The second circuit to drive a 24 V integrator, with a 2% zero flow cut off.

All power requirements other than 230 V will have to be provided for by the successful Tenderer.

The transmitter shall have facilities to adjust for the various pipe diameter and flow rates.

PLT 3 CLAMP-ON ULTRASONIC FLOW METERS

PLT 3.1 General Requirements

Single channel flow meters operated in transit time or time-of-flight mode shall be provided unless otherwise specified. The flow meter provided shall be capable of measuring the instantaneous flow in a pipeline and give the accumulated flow. The installation shall comprise at least two (2) sensing units (transducers) that are connected via co-axial cables and connected to a signal conversion unit. The signal unit shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalize flow and shall have a 4-20 mA and

pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

Welding of transducers onto the pipe will not be allowed.

The IP rating for the housing of the transducers shall be *submersible*.

The mountings on the transducers shall be manufactured by stainless steel.

The location of the flow meter installation shall be indicated on the relevant drawings, together with the following general information:

- Pipe outer diameter
- Pipe material
- Pipe wall thickness
- Internal lining
- Average thickness of internal lining
- Fluid to be measured
- Distance between transducers and signal converter

The operating temperature for all equipment shall be minimum -10°C and maximum 55°C.

PLT 3.2 Flow Accuracy

The flow accuracy (velocity) shall be $\pm 1\%$ of reading for pipe diameter greater than 150mm and flow velocities greater than 0.3 m/s. For pipe diameters smaller than 150mm, the flow accuracy shall be $\pm 3\%$.

The overall rangeability or turn-down ratio shall be at least 400:1.

The repeatability for clamp-on transducers shall be 0.2 to 0.5% of full scale reading.

PLT 3.3 Calibration

The Contractor shall allow for the calibration of the flow meter one month after installation by Technology Services International of Eskom enterprises. A certificate of calibration shall be submitted to the Engineer, acceptance of which signifies final completion of the installation.

PLT 3.4 Guarantee Period

The ultrasonic flow meter shall be guaranteed for a period of at least **24 Months** from date of **successful commissioning**.

PLT 4 FLANGED MECHANICAL TURBINE METERS

PLT 4.1 Equipment Preferred

All mechanical turbine meters shall be type Sensus or similar and approved.

PLT 4.2 Accuracy

All mechanical meters supplied in terms of this Contract shall perform to an accuracy of better than $\pm 2\%$ error over the meters operating range i.e. between Q_t (transitional flow) and Q_n (continuous flow). The performance characteristics of the meters offered shall be equal to or better than the values tabled below:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2
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Size (DN) (mm)	Q _{min} (m ³ /h)	Q _t (m ³ /h)	Q _n (m ³ /h)	Q _{max} (m ³ /h)
40	0.3	0.8	40	60
50	0.3	0.8	50	90
80	0.5	0.8	120	200
100	0.8	1.8	230	300
150	1.8	4	450	600
200	4	6	800	1200
250	6	11	1250	1600
300	12	15	1400	2000
400	25	50	2000	3000
500	45	60	3000	4500
600	100	180	3300	6500
800	210	320	6000	12000

PLT 4.3 General Requirements

Meters must be fitted with dry dial registers, which comprise 6 digit cyclometer-type totalizers, registering in kiloliters (kl) or m³. These registers must be sealed to prevent ingress of dirt or moisture. The registers, which are to be fitted as standard, must be able to provide one high frequency opto-type pulse output function and two low frequency reed-type pulse output functions. All flow meters shall be provided complete with frequency converter unit and opto coupler. The frequency converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

No consideration will be given to meter types, which necessitate the use of special tools or fitment of any form of gland in the process of connecting pulser units, or, meters which require a register-change to switch from one volume unit per pulse to another. Dismantling of registers for this purpose will not be acceptable. Tenderers are to provide full details of these aspects with their tenders.

Cover bolts must be of stainless steel material to facilitate easy removal of mechanisms. Meter bodies must be coated with a high quality sintered epoxy powder coating, both internally and externally, to provide maximum protection against corrosion.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream for each size of meter offered, to ensure that the accuracy of the meters remain within the stated limits, under normal operating conditions. Preference will be given to meter types requiring a minimum of straight pipe upstream and downstream, as installation space and lay lengths are at a premium.

The performance of the meters offered shall not be affected by outside magnetic influences.

Details of head loss across the meters offered shall be provided by the Tenderer.

PLT 5 ELECTROMAGNETIC FLOW METERS

PLT 5.1 General Requirements

All electromagnetic flow meters supplied under this contract shall be for high measuring accuracy i.e. $\pm 0.5\%$ of reading plus 0.05% of full scale. The repeatability or reproducibility of

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

measurement shall be $\pm 0.1\%$ of full scale. The meter shall have a long term zero stability of $\pm 0.2\%$ and linear variation shall be less than 0.2% .

Electrodes shall be manufactured from a high quality metal and shall be removable for cleaning purposes. Removal of electrodes with the line under pressure is preferred.

The minimum downstream and upstream unrestricted straight pipe run required for the specified measurement accuracy shall be stated by the Tenderer.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

The flow meter shall be equipped with a separate mountable signal converter unit complete with sufficient length of signal cable. The signal converter shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalized flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle supplied under the electrical scope of the Contract.

Electromagnetic meters and converters shall be suitable for outdoor installation and shall be adequately protection against lightning.

PLT 6 DIGITAL INDICATOR/INTEGRATOR

The display shall be a 6-digit, 0.56" (14.2mm) High Red L E D, giving a maximum display of 999999. The decimal point shall be selectable.

A flashing display shall be given during totaliser overflow.

The indicator/integrator shall be powered by 230 V AC at 50 Hz.

The indicator/integrator shall be constructed in such a way that it can be calibrated to the required flow and also by means of a selector button, display the accumulated quantity of water released.

The front bezel shall meet NEMA 4/IP65 requirements

The manufacturer of the indicator/integrator shall comply with ISO 9001 and proof of this to be submitted with the tender documents.

The indicator/integrator shall have a lock-out facility to limit operator entry to the programmable settings and totaliser.

The totaliser shall have a programmable time base with a scale factor of 0.001 to 100.0 and a low-end cut-out.

The remote indicator/integrator if required is to be fitted into an IP 66 enclosure in such a way that the flow reading is clearly visible with space available for the labelling and surge protection as specified.

PLT 7 INSTRUMENT PANELS

All panels will comply with the minimum requirements for an IP 65 rating.

All cable entries will be fitted with the appropriate cable gland. All cable glands will comply with IP 68.

Each enclosure is to be fitted with an M10 brass bolt and two nuts that will act as an earth bar. All surge protection in the enclosure to be grounded onto this bolt.

a) Local indicator/integrator

An instrument panel is required to house the flow meter power supply unit if required, indicator/integrator and surge protection and shall comply with the following:

1. At least 500 mm high, 400 mm wide and 200 mm deep.
2. Constructed from polycarbonate.
3. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
4. Be fitted with a plain painted metal chassis of at least 2.5 mm thick.
5. Be fitted with a polyester internal door for mounting of the totaliser.
6. The external door shall be fitted with a window that allows sight of the totaliser.
7. The external door shall have an extruded polyurethane seal fitted to a groove.
8. Only two closure points that are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
9. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

b) Remote indicator/integrator (if required)

An instrument panel is required to house the remote indicator/integrator and surge protection and shall comply with the following:

1. Constructed from polycarbonate.
2. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
3. Fitted with a polyester internal door or stand-offs for mounting of the totaliser.
4. The external door shall be fitted with a window that allows sight of the totaliser.
5. The external door shall have an extruded polyurethane seal fitted to a groove.
6. Only two closure points which are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
7. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

PLT 8 SURGE PROTECTION

Single phase 230 V AC medium protection units that are certified to withstand surges of up to 75kA.

Two wire, 230 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two wire, 24 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two explosion proof, pipeline spark gaps rated to withstand surges of up to 100kA, complete with pipeline mounting brackets and a fly lead of at least 300mm.

All surge protection units must be grounded to a common earth point in the panel that houses the ultra sonic flow meter. If a nut and bolt arrangement is used it shall be at least an M10 and shall be made of brass. Care has to be taken to ensure that the nut and bolt do not negate the IP 65 rating of the enclosure.

PLT 9 SIGNAL CABLE

All signal cable to be 1,5 mm², 4 core, twisted pair, braided screened cable.

PLT 10 EARTHING

The successful Tenderer is to supply 70 mm², stranded copper cable as well as lugs that will fit the cable and an M10 bolt to connect between the equipotential bar and earth mat.

The successful Tenderer is to supply 16 mm², green PVC insulated, stranded copper cable to connect between the common earth at the instrument panel and the equipotential bar.

PLT 11 EQUIPOTENTIAL BAR

An equipotential bar with cover must be suitably mounted within each flow meter chamber. Modular terminals should be provided to accommodate 3 connections of up to 16 mm², 3 connections of 16 - 95 mm² and 3 for flat connections up to 30 mm wide.

PLT 12 LABELS

Two types of labels are required. One for the site and installation name, the other giving details of the flow meter characteristics.

Labels to be manufactured from plastic engraved stock with white lettering on a black base.

Lettering to be 10 or 6 mm high x 5 and 3 mm wide and labels to be at least 105 mm X 30 mm.

All labels to be fitted with at least two strips of 12 mm wide double sided tape that run for the total length of the label.

PLT 13 GENERAL REQUIREMENTS

All screws, brackets, cable saddles, nuts, bolts, washers etc. used in the installation of the equipment shall be from stainless steel.

Before delivery to site all equipment and all parts supplied under this contract will be checked and certified at the supplier's workshop to ensure that they are in working condition by a delegated representative of the client.

PLT 14 COMMISSIONING

The equipment as supplied under this Contract shall be commissioned after **one fault free month** of operation.

If during this month the equipment or any part thereof should fail the successful Tenderer shall repair the equipment at his own expense and once again leave the equipment to operate for one fault free month before commissioning. All costs incurred shall be for the successful Tenderer’s account. This cycle to continue until one fault free month has been attained.

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

PTP : HOISTING EQUIPMENT

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

15 PTP - Hoisting Equipment - June25 June 2025

PTP HOISTING EQUIPMENT

PTP 1 ELECTRICAL CRANES

The cranes shall each comprise of an appropriate girder crane, traversing hoist, lifting rope for the main hook, control pendant, together with all necessary hoisting, travelling and traversing equipment and cable systems.

The hoisting, travelling and traversing motions shall be electrically operated by separate drives.

The hoist will have at least two falls of rope and will be supplied with a heavy duty rope guide to ensure close and accurate rope lay on the drum. The rope lay on the drum will be such as to ensure the maximum distance between the ropes on the drum at the point of maximum reach of the hook.

Each crane will be controlled by means of a single pendant fitted to the hoist – the cord to the pendant to be of sufficient length to control the hoist from the lowest floor level in the structure.

PTP 2 CHAIN-OPERATED CRANES

The chain operated cranes will run on a single straight traverse beam secured to the underside of the concrete beams at the chlorine store and the concrete roof at Montana pump station and will be chain-operated for lifting and travel. The tendered rate must include for the complete unit i.e. the beam, travelling trolley, hook, chain, chainbox and stop ends. The chain shall be hot dip galvanised.

PTP 3 DESIGN AND RATED CAPACITY

The crane shall be designed to comply with the latest amendments of BS466:1984, BS2573:Part 1:1983 and BS2573:Part 2:1980. The crane shall be suitable in all respects for service in the pump stations and workshop where it will be used for the installation and maintenance of electric-motor-driven pump sets assembled to close tolerances. Provision shall be made for such duties to be performed safely and effectively. The group classification of the mechanism shall be not lower than M3- Maintenance duty.

PTP 4 STRUCTURAL STEELWORK

The permissible stresses and design of the crane structures shall comply with Clause 6.2 of BS466:1984 and BS2573:Part 1:1983.

The crane shall be of approved design giving stiffness in all directions, and suitable gusset plate connections shall be provided where the carriages are secured to the crawl beam members to prevent any distortion or cross-whipping while travelling. The vertical deflections caused by the maximum safe working load and the test load suspended from the centre of the span shall be stated in the Technical Schedules.

Double traversing rails of adequate strength shall be securely fixed on each crawl beam.

PTP 5 END CARRIAGES

The end carriages shall be of approved design and stiffness in accordance with BS466:1984 and BS2573: Part 1:1983 and suspended via twin set rail wheels from the crawl beams. Provision for easily accessible lubrication shall be made and the type of bearing shall be stated by the Tenderer. Wheel bearings shall be removable. The end carriage shall be provided with suitable buffers to engage with the end stops to the crawl beams.

Steel tyred wheels shall have cast iron or cast steel centres. Tyres shall be supplied in accordance with BS3037.

PTP 6 TRAVERSING HOIST

The framework of the hoist shall provide stiffness in all directions and full particulars of the mechanism shall be submitted for approval. The hoist gear box shall be totally enclosed and arranged for oil bath lubrication. Preference will be given to a centralized group of nipples for grease gun lubrication of all journal bearings.

The hoisting gear shall be so arranged that the main load is evenly distributed on the hoist wheel bearings to avoid distortion due to uneven loading.

Wheel bearings shall be renewable

PTP 7 DRIVES

Machine cut gears of high carbon steel shall be used throughout.

The Contractor shall guarantee that the drive between the hoisting and lowering motor and the drum is non-reversible under the mass of the rated maximum load.

PTP 8 HOISTING DRUMS

The hoisting drums shall be of robust manufacture in fabricated mild steel. The length of the drums shall be capable of taking the full amount of rope without overlapping. At least three full turns of rope shall remain on the drum when the associated hook is in its lowest position. The diameter of the drums and the depth of the machined spiral grooves shall conform with the requirements set out in BS466:1984 for class 4 cranes.

PTP 9 BRAKES

A brake of approved electrical-mechanical type shall be provided on each of the hoisting and lowering systems of the crane and hoist. Each brake shall be so designed that in the event of failure of the electrical supply it shall arrest and hold any load up to and including the test load at any position of the lift. The brake is to be electrically operated and shall be released as soon as the supply is switched on to the hoisting motor. Immediately the supply is switched off, or in the event of a power failure, the brake shall be applied instantly. The brake shall bring the motion, with or without load, to rest without shock.

An electrically operated brake similar to that on the hoist mechanism shall also be provided on the travelling and traversing motions of the crane and hoist.

Braking mechanisms shall comply with BS466:1984 and full particulars shall be submitted with the tender.

PTP 10 ROPES

All crane ropes shall be of special flexible steel wire complying with BS302, BS621 and ISO2408. The length of the ropes supplied shall permit the hoisting conditions to floor levels shown on the drawings.

Duplicate copies of certificates of test and inspection for each rope shall be supplied by the Contractor giving the results of every examination and the nature of the tests carried out.

Particulars of the ropes shall be given in the Technical Schedules, Series 21.

PTP 11 FALL BLOCKS AND HOOKS

The fall blocks shall be of mild steel construction with approved sheaves. The grooves shall be machined in accordance with BS466:1984. The sheaves shall be provided with bronze bushings bored to fit the centre pin and provision shall be made for the proper lubrication of these bearings.

The proportions of the fall blocks and the suspension arrangements shall be such as to ensure that twisting of the blocks does not occur.

The hooks shall be of the swivelling type with safety latch mounted on ball bearings and the material and design shall comply with BS2903 and BS3017 as applicable.

PTP 12 GANTRY I-BEAMS

The gantry rails shall be supplied and installed by the Contractor in accordance with BS 466:1984 Appendix F.

The gantry I-section shall be levelled by means of packing plates between the portal frame and the bracket if required.

The gantry beams have been designed for bending moments and shear loads generated by the following load conditions. Actual load conditions of the proposed crane shall be stated in the Technical Schedules.

Fixed endstops shall be supplied, installed and positioned at each end of the gantry I-beams and a suitable mechanism shall be fixed to the gantry I-beams to ensure that the limit switches on the crane are actuated to stop the long travel motion of the crane prior to any contact with the fixed endstops.

PTP 13 ERECTION AND SITE TESTING

After installation at site the crane will be subjected to the tests specified in clauses 44.2, 44.3 and 44.4 of BS466:1984.

The overload, deflection and performance tests specified in clauses 44.5, 44.6 and 44.7 of BS466:1984 may be carried out either at the Contractor's works or on site. In either case the vertical deflection of the main girders shall be measured to provide compliance with BS466:1984 clause 7.

If the overload tests are to be carried out on site the Contractor shall include for the supply, transport to and from the site, offloading and re-loading of all test weights, cradles and slings, etc, necessary to carry out the tests and the requisite instruments for measuring the deflection.

PTP 14 PAINTING

PTP 14.1 Preparation of surfaces

No paint shall be applied before the work has been inspected and approved; cleaning of metal surfaces prior to painting shall be approved by the Engineer's Representative.

All surfaces except those of machined parts shall be grit or shot blasted in accordance with SANS Specification 10064 : 2005 Clause 2.3.3 followed by vacuum or air cleaning to render a white metal finish equivalent to ASA 2½ of Swedish Standard SIS05 5900-1967.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTP 14.2 Painting

All steelwork shall be painted at the manufacturers factory with one coat of Plascon zinc chromate primer followed by one coat of Plascon Universal Undercoat and finally one finishing coat of Plascon "Golden Yellow" Universal Enamel SANS colour number B49.

Where surfaces are to be in permanent contact they shall receive one coat of primer and the surfaces brought together and jointed whilst the paint is still wet. All shafts, gears, roller faces etc shall be suitably protected against corrosion.

All surfaces of metal work which cannot be painted in situ shall be thoroughly cleaned before assembly and painted to the satisfaction of the Engineer. The Contractor shall take special care that all internal parts are cleaned thoroughly and wire brushed where necessary before they are erected. Materials stored on site shall be maintained in the same condition as despatched.

After erection all bright parts shall be cleaned and polished and the finished coat of paint shall be touched up where required.

Other items of equipment including electrical panels, isolating switches, etc shall be painted in colours to be decided by the Engineer.

During site painting of the equipment the Contractor shall make provision for the protection of adjacent plant, buildings and floor against damage and the plant and floors shall be covered with protective sheets.

PTP 15 ELECTRICAL EQUIPMENT

PTP 15.1 General Requirements

The electrical supply for the crane will be from a 400 V, 3-phase, 4-wire, 50 Hz RWBR phase rotation system with the star point of the main supply transformer connected to earth and all components shall be suitable for operation at 400 V + 10% - 20%.

The crane motors and brake mechanisms shall be operated by contactors and all motions shall be controlled from a pendant control. The mass of the pendant control shall not be supported by the electric cable; a suitable steel rope shall be provided to support the pendant.

All the electrical equipment, including the down shop conductor system control panel, cabling, wall mounted isolator, pendant controller for the crane shall be supplied. A 400 V, 3 phase, 4 wire power supply cable, protected by a circuit breaker to the main isolator for the crane will be supplied under a separate contract.

The main power supply to the crane through a three-pole circuit breaker supplied and a main isolator for the crane will be supplied under a separate contract. The Contractor shall supply and install the cable between the collector system and the isolator.

All control panels, junction boxes etc shall be located such that safe access is possible irrespective of where the crane is positioned or without having to erect special platforms, scaffolds etc.

PTP 15.2 Motors, Brake Solenoids and Contractors

All motors shall be totally-enclosed fan-cooled IP 55 squirrel cage induction type and shall conform to SANS IEC 34. All motors, unless otherwise approved, shall be fitted with ball or

roller bearings. The motors shall be rated for at least 240 starts per hour at a design altitude of 1 800 m above mean sea level, and shall be adequately rated for the duty.

All brake solenoids shall be adequately rated to prevent burn-out under the most arduous operating conditions and if it is considered necessary shall be provided with protective cut-outs connected in the appropriate motor control circuit.

Each motor shall be controlled by a AC4 crane duty rated reversing contactor comprising two 3-phase air-break contactors mechanically and electrically interlocked to prevent simultaneous closing. Thermal time-delay overload elements shall be fitted in each phase for normal motor overload protection. Fault protection shall be provided by means of one suitably rated MCCB for each motor.

Each motor control circuit shall be provided with a separate control miniature circuit breaker and link so that individual control circuits can be isolated for test purposes.

The tender shall include full details of the contactors and thermal overloads offered which shall be suitable for AC 4 crane duty.

PTP 15.3 Pendant Controller

Control of all motions of the crane shall be by means of a pushbutton pendant controller. The control system shall operate on a nominal 110 V single-phase, centre earthed supply derived from a 400 V/110 V double wound transformer.

Individual control pushbuttons shall be provided for each direction of the long travel and cross travel motions of the crane; these buttons shall be held pressed to maintain the required motion.

Individual control pushbuttons shall be provided for each of the hoisting and lowering motions of the crane; the appropriate button shall be held pressed while the crane is lowering or hoisting.

The pushbutton pendant controller shall move independently of the crab, and shall be operated in any position along the span of the crane. The crane shall be operated from the floor level. Full particulars of the method of supporting and moving the pendant controller to any position and the method of adjusting the level of the pendant controller shall be stated in Schedule IV.

An emergency on/off switch shall be provided on the controller to break the control circuits of the crane in the event of any pushbutton sticking.

Full details of the pushbutton pendant controller shall be submitted with the tender.

PTP 15.4 Control Buttons Or Switches

The control pushbuttons for the crane shall be of substantial heavy duty construction and shall be of the best quality that can be obtained for the purpose; sample of the type of pushbutton it is proposed to use shall be submitted to the Engineer for approval.

PTP 15.5 Control Locking Arrangements

A detachable locking key shall be provided for the crane controller and it shall not be possible to operate any of the crane motions unless the key is inserted; the key may be incorporated with the emergency switch specified in subclause TS 2.3. An indicating light shall be provided on the controller to indicate only when the crane control supply is switched on.

PTP 15.6 Control Panels

The crane control panels shall be manufactured from mild steel and shall form a robust enclosure affording IP 55 degree of protection. The panels shall be painted light orange, colour B26 to SANS-1091. The control panels shall be positioned so as to permit safe access from the walkway on the main bridge and without having to position the crane in any special position.

The main circuit breaker on the panel shall be fitted with a door mounted operator that shall be mechanically interlocked such that it shall only be possible to open the door if the main circuit breaker is in the off position.

PTP 15.7 Limit Switches

Limit switches shall be provided for limiting the hoisting, lowering, travelling and traversing motions of the crane. These limit switches shall operate to cut out the appropriate contactor and apply the brakes. Operation of the limit switches shall not necessitate hand resetting of any equipment on the crabs or bridges. An additional limit switch which shall be operated by the fall block lifting a pendant weight shall be provided on the hoist of the crane and shall be set out at the ultimate hoisting position.

One rope fall of the hoist shall be fitted with a suitably rated load limiting switch of the "Liftco" or equivalent pattern. The switch shall be installed in the crane manufacturer's works and set during load testing to trip the hoist mechanism at a load not exceeding 110% of the specified load. The Engineer's Representative shall witness the setting of the switches.

All limit switches shall be mounted on the crane, shall be of substantial heavy duty construction and of the best quality that can be obtained. Details of all limit switches shall be submitted to the Engineer for approval.

The operating ramps for the limit switches for the travelling motion of the crane shall be installed at the ends of the building in positions to be agreed with the Engineer.

PTP 15.8 Down Shop Conductors

An enclosed busbar collector system shall be supplied for the long travel motions of the crane and shall include the supply and erection of collectors and brackets complete with supports from the crane and gantry rails and the drilling of the fixing bolt holes.

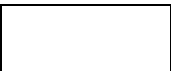
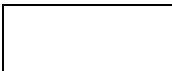
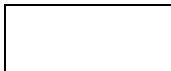
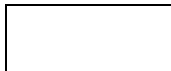
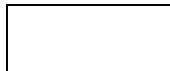
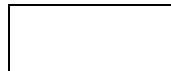
Adequate arrangements shall be incorporated for easy maintenance; the Tenderer shall state in the Price Schedule the price adjustment required for the supply of a Vahle PVC-enclosed busbar collector system as an alternative to any other make which may offered. A platform shall be provided to give access to the collectors on the down shop conductors.

The down shop conductor cross-sectional area shall be suitable for the supply connection at one end and a volt drop of less than 2 per cent when the crane is drawing maximum load current at the remote end. The enclosed busbar systems shall be designed and constructed to ensure the minimum amount of maintenance and full details of the down shop conductor systems offered shall be submitted with the tender. See Schedule IV.

The length of the down shop conductor system to be provided shall be determined from the long travel distance given.

The Contractor shall be responsible for the installation and proper alignment of the entire busbar system for both the travelling and traversing motions.

Festoon systems are acceptable for:-

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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Cross travel motions on the crane.

The independent pendant travel on the crane.

PTP 15.9 Wiring, Terminals and Labels

The terminals and wiring shall be totally enclosed by means of galvanized metal conduit and covers or by other approved means and there shall be no possibility of oil coming into contact with any insulation unless such insulation is of approved oil-resisting type.

Only PVCPVCSWAPVC cable will be considered as an alternative to conduit-protected wiring.

Power wiring shall be carried out in standard phase colours, red, yellow, blue and black for neutral.

All power wiring shall be terminated onto bolted terminals complete with washers, nuts and locknuts and separated by flash barriers insulated for 660 V.

All control wiring shall be terminated by means of approved crimped lugs onto approved klippon or equivalent spring loaded terminals suitable for 6 mm² conductors.

All power wiring terminals shall be grouped together and the various terminal groups shall be identified by means of engraved sandwich board labels attached by means of cheese-head brass screws.

All relays, contractors etc, shall be identified by similar labels as specified above.

All control circuit wiring shall be numbered at all terminal points with engraved interlocking ferrules and these numbers shall appear on all schematic and wiring diagrams.

Unless otherwise approved, all secondary wiring shall be carried out in 660 V grade 2,5 mm² PVC insulated multi-stranded copper conductor with a minimum of 7 strands per conductor bearing the mark of approval of the South African Bureau of Standards.

PTP 15.10 Earthing

The crane rails shall be electrically bonded together with 35 mm² minimum stranded copper conductor and an additional conductor shall be supplied as part of the down shop conductor system exclusively for earth continuity.

The crane earthing system shall be continuous and shall terminate at a point adjacent to the isolator specified.

On no account shall cable armouring be used for earth continuity.

PTP 15.11 Insulation

All wiring shall be insulated to a level suitable for operation at 600 V. All wiring will be pressure-tested by means of a 1 000 V megger before the equipment is put into service.

PTP 15.12 Schematic and Wiring Diagrams

Complete single line and schematic diagrams of all main and control circuits for the crane and separate hoist shall be submitted to the Engineer for approval within four weeks after the contract is placed. The schematic diagrams shall each include a detailed list of components showing type, make, rating, etc.

Manufacture of any equipment shall not be commenced until such time as approval has been obtained for the schematic diagrams. The single line diagram shall show the motor ratings.

Symbols used in electrical drawings and schematics shall be drawn to NRS Specification 002-1990 requirements.

Final approved schematic diagrams of all main and control circuits of the crane and hoist shall be supplied. The Taking-Over Certificate will not be issued until all such diagrams have been received.

A photographic sepia copy of the approved schematic diagram shall be fixed to the inside of the doors of the cabinet housing the control equipment of the crane. The photograph shall be of adequate size to permit all details to be easily read, shall be non-fading and shall be covered by a clear perspex sheet.

PTP 15.13 Detail Electrical Equipment

The Engineer shall approve the make and type of motors, contractors, pushbuttons and collector systems, type of wiring, construction and arrangement of the control panels, etc, before any items are ordered from sub-contractors or their manufacture commenced.

PTP 15.14 Electrical Tests on Site

All apparatus shall pass such tests on site as are required by the Engineer to prove compliance with the specification independently of any tests which may have been carried out at the manufacturer's works. In particular all electrical pressure tests made at the manufacturer's works shall be repeated on site.

The tests shall include, but shall not be limited to the following:-

- (a) Megger testing of all cables and wiring using a 1 000 V Megger.
- (b) All motors and brakes shall be meggered using a 1 000 V Megger.
- (c) All safety devices shall be set and tested for functionality.
- (d) Down shop conductors shall be checked for alignment and contact.
- (e) Access to all control panels shall be checked for ease of access and safety.

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PTW : ELECTRIC ACTUATORS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PTW ELECTRIC ACTUATORS

PTW 1 SCOPE

This section comprises the specifications electric actuators to be fitted to valves of various types.

All actuators shall be complete with provision for local manual operation.

PTW 2 COMPLIANCE

Actuators for the motorised operation of valves shall comply with this specification in all respects.

PTW 3 GENERAL DESIGN REQUIREMENTS

PTW 3.1 The actuators shall be designed for a minimum maintenance free life of 10 000 open/close/open cycles, assuming maximum seating torque at the end of each stroke and an average of 33% of maximum seating torque during each stroke.

PTW 3.2 The available torque transmitted to a valve shaft through an electric or manual actuator shall be rated to include a 25% safety factor in addition to the maximum torque required to fully open or close the valve under the maximum working pressure and prevailing flow conditions.

PTW 3.3 One actuator size (same outside dimensions) shall be available to cover output speeds from 4 to 90 rpm for a given torque range, to avoid over sizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators.

PTW 3.4 The safety margin or motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum value torque with the supply voltage 10% below the nominal value.

PTW 3.5 Actuators shall have a function to hold the gate/disc in any fixed position for an extended period.

PTW 3.6 All valves shall be capable of being opened or closed under an unbalanced pressure equal to the nominal pressure.

PTW 3.7 Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from -10°C to 40°C at a maximum relative humidity of 95%.

PTW 3.8 All actuators must be suitable for operating in any mounting position.

PTW 3.9 The design must provide simple setting, testing, maintenance and repair. Torque and limit switching shall preferably be of the mechanical type. Should the settings be done with special tools or instruments (e.g. battery backed setting tools), one setting tool shall be provided for each unit process e.g. pump station, filter, etc.

PTW 3.10 All materials used shall be suitable to withstand operation under specified environmental conditions. All necessary precautions shall be taken to avoid any type of corrosion and electrochemical effects, which many take place between different kinds of metals.

PTW 3.11 For rising stem applications, the design must allow to remove the actuator from the output drive without disturbing the function of the valve.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- PTW 3.12** The electrical connection of actuators shall be made by plug/socket connector, to allow quick disconnection in case of maintenance or repair and use of portable test equipment for pre-commissioning testing.
- PTW 3.13** No plastic parts of any type shall be used, except for electric/electronic components, operating knobs/levers, mechanical position indicators and sealing elements.
- PTW 3.14** In order to minimise the amount of spare-parts required, parts like switches, covers, plug/sockets, limit- and torque-switching gears etc. must be interchangeable throughout the model sizes installed.
- PTW 3.15** Actuators shall be designed in such a way, that exposure to environment will not interfere with the safe operation. All joints shall be sealed by radial seals or O-rings, watertight to IP68.
- PTW 3.16** Depending on valve application, actuators shall be self-locking. Self-locking shall remain active even if the actuator is switched into hand-operation-mode.
- PTW 3.17** Commissioning tools shall be provided with the actuators and must meet the enclosure protection and certification levels of the actuators.
- PTW 3.18** Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage.
- PTW 4 POWER SUPPLY**
- PTW 4.1** The actuator shall be designed to operate from a 380 V three-phase or 230 V single phase, 50 Hz a.c. power supply. The actuator shall be capable of operating at the rated duty with a $\pm 15\%$ variation of the applied voltage measured at the actuator.
- PTW 4.2** The actuator shall be provided complete equipped with the necessary auxiliary equipment to provide the low voltage power required by its control circuits.
- PTW 4.3** The actuators shall have the correct phase rotation of the power supply after the site wiring and connections have been made.
- PTW 5 ELECTRIC MOTORS**
- PTW 5.1** The motor shall have a minimum duty rating of four consecutive complete cycles per hour or a continuous duty of 15 minutes, whichever is the more onerous.
- PTW 5.2** Gear driven actuators shall be fitted with a low inertia, high starting torque, low stall torque, purpose designed electric motor.
- PTW 5.3** Motors must be protected by 3 thermal contacts, which are embedded in the motor windings. Motor connections shall be internal by the means of plug and socket (up to 5 kW).
- PTW 5.4** The electric motor shall be Class F insulated, with a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is the longer, at an average load of at least 33% of maximum valve torque.
- PTW 5.5** Electrical and mechanical disconnection of the motor in any position should be possible without draining the lubricant from the actuator gear case.
- PTW 5.6** The locked rotor current of motors shall be specified to permit adequate sizing of the power supply cable. The voltage at the motor during starting shall not drop below 85% of the nominal supply voltage.

PTW 5.7 Single phasing protection shall be provided to ensure that the motor is not operated with only two of the three phases of the power supply present.

PTW 6 CONTROL FACILITIES

PTW 6.1 Integral Motor Starters

Integral actuator control, whereby the entire actuator, motor and stop/start control, forward/reverse control and starter are integrally mounted in the actuator enclosure, are preferred.

The reversing contactor starter shall in all cases be electrically and mechanically interlocked.

The following features shall be in the integral motor controls

- Reversing contactors (mechanically and electrically interlocked). An electronic reversing unit (thyristor) shall be available as an option up to 1,5 kW.
- Programmable control logic in CMOS SMD-technique.
- An interface board for digital two wire control communication shall be available.
- It shall be possible to have direct communication between actuators and higher level DCS systems, without using additional master stations as protocol translators.

The two wire communication shall include:

- Data transmission speed shall be programmable in the range of 110 to 56.400 bit/sec.
- Interface shall be: EIA-485 (RS 485).

Commands:

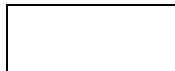
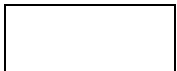
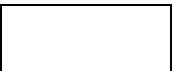
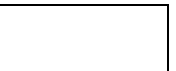
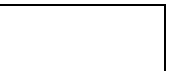
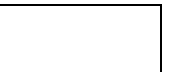
- Run OPEN / run CLOSE / STOP.
- Valve position control (only) on modulating valves.
- Run to an intermediate position.
- Performs an emergency operation.

Indications:

- Valve positions OPEN / CLOSED.
- Running indication (opening / closing).
- Mode of operation – position of selector switch OFF / LOCAL / REMOTE.
- Actuator operated manually by handwheel
- Fault indications:
 - phase sequence and phase failure.
 - thermo switch tripped.
 - torque switch in 'OPEN' direction tripped in mid travel.
 - torque switch in 'CLOSE' direction tripped in mid travel.
 - failure of supply voltage of Profibus interface.

The actuators supplied under this contract will all be hardwired to the local PLC. No actuator will be required to be connected to a bus (i.e Profibus, Modbus, ect) system. Non of the actuators will be modulating. All the actuators must have a 24V DC or Potential free output for the open and close limits, running and trip indications. The actuator must also have 24V DC inputs for open and close control. On the filters only the inlet valve will have a 4-20mA input and 4-20mA output (feedback) additional. These valves will be opened to 25% for a time period before opening 100%.

For more detail on the operation of the actuators also read the specifications in Volume 3.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTW 6.2 Integral Pushbutton Stations

The actuator shall be provided with an integral pushbutton station with the following features:

- Local/Off/Remote selector switch. The switch shall be padlockable in each position.
- Open, Stop and Close pushbutton station. The Open and Close pushbuttons shall only operate when a local selection is made on the selector switch. The Stop pushbutton shall be of the emergency latching type and shall operate in all positions of the Local/Off/Remote selector switch.
- Digital or mechanical local indication of the valve percentage open or fully open/closed status.

PTW 6.3 Provision shall be made to orientate the local controls through increments of 90°.

PTW 6.4 Should actuators have to be mounted where access is difficult, it shall be possible to separate the local/motor controls (including motor controls) from the actuator. A wall bracket shall be available as an option to mount the local controls/ motor controls at a convenient position near the actuator.

PTW 6.5 It shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energisation of the contactor coils.

PTW 6.6 The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 1.1 kV.

PTW 6.7 The following options shall be available:

- Operational data logging via RS 232:
 - total running time.
 - total number of starts.
 - total number of torque switching.
 - total number of limit switching.

- Three position modulation:

A positioner can be provided within the equipment if specified. The nominal position value shall be sent as reference input from an external controller to the actuator. The integral positioner generates the signal for the motor controls, depending on the difference between input command signal and position feedback signal. Position feedback is provided within the actuator.

- Cable redundancy, change over automatically.
- Communication failure function (fail open, fail close, fail as, fail to preset position).
- Analogue sensor connection:

The actuator shall be additionally equipped with an interface enabling the connection of an external analogue sensor (0/4 to 20 mA).

- Digital sensor connection:

The actuator shall be additionally equipped with four digital input signals for connection of external sensors.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PTW 7 ACTUATOR MOUNTINGS

PTW 7.1 The actuator shall be mounted directly onto the valve body or gearbox. Should a particular application require an adaption device, any such device shall be a specific proprietary design for a particular type of valve. A comprehensive design of any such adaption shall be submitted to the Engineer for approval.

PTW 7.2 Provision shall be made for a weep hole to release any seepage water from the valve in order to protect the gearbox/actuator from contamination.

PTW 7.3 The attachment of the actuator to the valve body shall be such that the actuator may be detached without disturbing the valve position.

PTW 7.4 The valve manufacturer shall ensure that there is no visible movement of the actuator on the mounting adapter or valve body when the actuator is in operation.

PTW 8 MONITORING AND PROTECTION

The following monitoring and protection systems shall be provided:

PTW 8.1 Position Indication

PTW 8.1.1 The actuator shall be equipped with a local indicator which continuously shows the valve travel from fully open to fully closed and vice versa. The indicator shall be based on a mechanical principle to show the valve position during electric or manual operation.

PTW 8.1.2 The actuator shall be equipped with a potentiometer for internal position transducer.

PTW 8.2 Torque Limit Switches

PTW 8.2.1 Torque limit switches shall be provided to sense an overload condition in either clockwise or counter-clockwise operation to protect the valve and actuator. These torque switches shall be adjustable over the entire torque range specified for the actuator. A back-up torque limit switch shall be provided with a "faulty system" warning light.

PTW 8.2.2 Torque- and limit switch setting devices must be easily accessibly for adjustment.

PTW 8.3 Travel Limit Switches

Travel limit switches shall be provided to stop the actuator at the required extremes of travel and shall be set to trip the actuator operation before the actuator torque limit switches are activated. The positions of these travel limit switches shall be adjustable, permitting adjustment to the valve shaft travel. These limit switches shall remain synchronised with the valve shaft travel for both motor and hand powered actuator operation. Provision shall be made for protection against unauthorised tampering with these limit switches.

The electronic limits must remain set in the event of a power failure should the actuator be operated beyond these limits by hand.

PTW 8.4 Potential Free Switch Contacts

Potential free switch contacts for remote and local indication of:

- Travel limit – valve open/closed.
- Torque limit exceeded.

Contractor

Witness 1

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These switches shall be installed to indicate whether the actuator has tripped on either limited travel or excessive torque.

PTW 9 ENCLOSURES

PTW 9.1 The enclosure(s) housing the mechanical, electrical and electronic components of the actuator shall be rated to IP68 of SABS 1222. The Contractor shall provide documentary proof that this requirement is met.

PTW 9.2 Cable entry into the termination compartments of the actuators and control panels shall not impair the IP rating of the enclosure.

PTW 9.3 All cable glands shall be fitted with watertight UV stabilised plastic boots and shall be supplied with the actuator.

PTW 9.4 Anti-condensation heaters shall be provided in all compartments of the enclosure housing the components of the actuator.

PTW 9.5 Lead seals shall be affixed via wire through the body and cover on all electric compartment housings after final setting and wiring of the actuators by a qualified actuator service Engineer.

PTW 10 WIRING AND TERMINALS

PTW 10.1 Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power.

PTW 10.2 Each wire shall be clearly identified at each end.

PTW 10.3 The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.

PTW 10.4 All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection.

PTW 10.5 A durable terminal identification card showing the plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

- Serial number.
- External voltage values.
- Wiring diagram number.
- Terminal layout.

PTW 10.6 Limit- and torque switches must be wired to actuator plug/socket. The same applies to additional switches and communication signals.

PTW 10.7 The terminal compartment shall provide sufficient space to accommodate the possible maximum number of incoming wires. Separate cable entries must be provided for:

- motor power cables.
- connection for redundant bus cabling and the required final resistors for bus termination.

PTW 10.8 Each actuator shall be provided with an adequately sized internal and external connection for earthing.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTW 11 MANUAL OPERATION

- PTW 11.1** All valves shall have a manual backup operation in order to open/close the valve during emergency conditions.
- PTW 11.2** The position indicator shall remain synchronised with the actual position during manual operation.
- PTW 11.3** Closure of valves shall be through the clock-wise rotation of hand wheels. All valves shall be capable of being opened or closed under an unbalanced pressure equal to the Nominal Pressure. The effort required on hand wheels to open or close valves under these conditions shall not exceed 90 N.
- PTW 11.4** A manual de-clutch lever shall be provided which, when operated, shall disengage the electric mechanism.
- PTW 11.5** The face of the handwheel shall be clearly marked with an arrow and the word 'CLOSE'.
- PTW 11.6** The handwheel must be sized in such a way, to allow convenient operation of the output drive. The torque switches shall be active in manual operation mode as well, thus allowing to provide a signal when the set-torque has been reached.

PTW 12 GEARBOX DRIVE UNITS

- PTW 12.1** Gears shall be machine cut and totally enclosed in weatherproof enclosures.
- PTW 12.2** Shafts, gears and other rotating components shall be supported on heavy-duty roller bearings to provide the highest possible efficiency.
- PTW 12.3** Bearings shall be of the anti-friction or self-lubricating type.
- PTW 12.4** Power gears shall be from heat-treated steel. Worm-wheels shall be made of bronze material.
- PTW 12.5** The gearbox shall be coated internally to 125 µm and externally to 250 µm of two-pack epoxy with a final coating of 50 µm recoatable polyurethane.
- PTW 12.6** A weep hole (diameter 10 mm minimum or machined groove 10 wide and 4 deep) shall be provided between the valve and gearbox to release any seepage water in the event of seal failure.
- PTW 12.7** The design should be such as to permit the opening of the gearcase for inspection or disassembled without releasing the stem thrust or taking the valve out of service.
- PTW 12.8** The actuator gearing shall be totally enclosed in a oil-filled gearcase suitable for operation at any angle.
- PTW 12.9** The gearbox lubricants shall be such that the gearbox can be mounted at any angle without any lubricant leaking from the gearbox enclosure.
- PTW 12.10** If a gearbox is 100% filled with lubricant, the gearbox shall be provided with a maintenance free membrane breather with sufficient capacity to accommodate the expansion of the lubricant over the full temperature range.
- PTW 12.11** Gears shall be fully covered with the lubricant in order to prevent corrosion.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PTW 12.12 Easily replaceable shear pins shall be provided on gearboxes to prevent damage to the valve if excessive force is applied on the handwheel in the fully open or closed positions. A spare pin shall be attached to each valve. The shear pins shall be detailed and specified in the manufacturer's operating manual.

PTW 13 NAME PLATES

PTW 13.1 Two nameplates, made out of stainless steel, shall be attached to each actuator; one on the motor housing, showing all relevant motor data, one on the actuator housing showing all relevant actuator data. Special information, like the valve tag no., shall be shown if required.

PTW 13.2 The nameplates shall be securely fixed to the actuator and motor, so that they cannot be removed or scratched off during shipment, installation, operation or maintenance.

PTW 14 CORROSION PROTECTION

PTW 14.1 Actuator painting must be performed in such a way, that no corrosion takes place under the ambient conditions as specified. All external screws or bolts shall be made out of stainless steel.

PTW 14.2 Surface preparation for cast iron parts shall be sand blasted, equivalent to Sa 2½ according to SIS 0559 000-1967 / DIN 55 928, part 4.

PTW 15 PNEUMATIC ACTUATORS

Actuators shall be designed to match their valves operating requirements.

Actuators shall be fabricated of non-corrosive materials and shall be mounted using stainless steel mounts and couplings. Fasteners shall be of stainless steel.

Unless the system configuration clearly does not require it, automatic spring-closing shall be provided to ensure that the valve closes (if open) or remains closed (if closed) upon power failure or failure of the air supply. The spring shall be of stainless steel.

Linear actuators shall be provided with stainless steel cylinder piston, cylinder rod and attachments. For open/shut duties, actuator force rating shall be at least 200% of the start-opening or shut-off force, whichever is higher, specified by the valve manufacturer for this application (after any mechanical advantage has been taken into account). Manual operation, by lever or equivalent, shall be provided in addition to pneumatic operation.

For open/shut duties of rotational actuators, torque rating shall be at least 200% of the start-opening or shut-off torque, whichever is higher, specified by the valve manufacturer for this application (after any mechanical advantage has been taken into account). Manual operation, by handwheel or equivalent, shall be provided in addition to pneumatic operation. The air supply to each actuator shall be fitted with a filter-regulator unit with an automatically operating water drain trap.

PTW 16 MEASUREMENTS AND PAYMENT

Actuators will be measured as part of the value complete per unit.

PTW 17 PREFERRED EQUIPMENT

Auma actuators are the preferred equipment, and should tenderers offer any other actuators in their main bid, Auma shall be offered as an alternative."

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

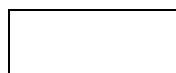
PTY : CONVEYOR EQUIPMENT

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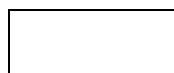
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Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



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PTY 1 SCOPE

This specification covers the detailed design criteria, manufacture, supply, installation, test and commissioning of mechanical belt conveyor systems for the conveyance processed sludge at a waste water treatment works.

PTY 2 INTERPRETATIONS

PT 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 Bureau of 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

PT 2.2 Standards

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

SANS 1168, 1313 and 1173	: Conveyor equipment
ISO 5048	: Design of Conveyors
ISO 5048	: Continuous mechanical handling equipment,- Belt conveyors with carrying idlers,- Calculations of operating power and tensile forces
SABS 400: 1990	: National Building Regulations
BS 5304: 1988	: Code of practice for safeguarding of machinery
SABS 044 Part III to IV: 1993	: 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
SIS 05 59 00	: Pictorial Surface Preparation Standards for Painting Steel Surface

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PTY 3 MATERIALS

PTY 3.1 General

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document, comply with the requirements of the most recent edition of the appropriate South African or other internationally recognised standard specification.

For each type of equipment, the Manufacturer shall indicate the materials used for each of the proposed sub-assemblies. The equipment shall be manufactured using new prime quality materials taking into account the latest technical innovations.

All components shall have a surface finish in relation to their importance, their position and their intended purpose.

Rolled steels and all castings shall be clean and free of blisters, porosity, shrinkage, holes, cracks or other flaws that may be detrimental to their use.

The Tenderer shall indicate in his tender the proposed materials for each component of the assembly.

General Requirements

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

PLV: Particular Specification for Colour Codes

PLQ: Particular Specification for Corrosion Protection

PTY 4 DESIGN OF CONVEYOR EQUIPMENT

PTY 4.1 General Design Parameters

Equipment shall be designed:

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- To ensure safe and satisfactory operation and an acceptable life expectation under the 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 facilitate inter-changeability of units and/or sub-parts throughout the contract works with regards to new equipment and equipment and/or sub-parts currently being used on the existing Beenup plant.
- To operate without undue vibration and excessive noise. Maximum of 84dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements (as listed in section 1) 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.
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.
- As a minimum, components shall be selected with a service factor of 1.5 applied to the maximum operating power to be transmitted or otherwise as per the manufacturer's recommendations.

PTY 4.2 Belt Conveyors Design of Parameters

All plant and equipment shall be designed to operate satisfactory under atmospheric, ambient and other conditions specified in the Project Specifications.

All conveyors shall be designed for a surcharge angle of 0° and a troughing angle of 35°. Design tonnage and maximum tonnage for belt conveyors shall be for a digested sludge cake of 20-25% dewatered from a belt press process. No additional percentage shall be applied to the maximum feed tonnage to obtain a maximum design tonnage.

The maximum belt speed for a conveyor system shall be 0.25 m/s. Conveyors shall be capable of starting up under full load.

Inclination of conveyors shall be such that no runback of material occurs when the belt is loaded. The maximum inclination of any conveyor will be 14°.

Conveyor radii will be selected such that no lifting of the belt from the idlers shall occur when the belt is started with no load at the curve, but fully loaded from the curve back to the tail pulley.

Gearboxes shall be standardised as far as is possible. Integral holdbacks shall be provided for conveyors where required. Speed reducers shall be of the helical geared, shaft-mounted types. Gear unit ratios shall be based on 4 pole, 50Hz motors with the minimum gear unit service factors being 2.0 based on installed motor power. Thermal and mechanical service factors shall be selected such that the gearbox shall be able to operate effectively without the risk of excessive heat build-up under all operating and ambient conditions specified.

All conveyor equipment will comply with SANS 1173. In the design of the equipment, special consideration shall be given to the standardisation of such parts as pulleys, gearboxes, hold-backs, couplings, shafts, bearings, electric motors, etc. reducing spare equipment to a minimum.

Belt widths, belt speeds and transfer points shall be designed with particular attention to the prevention of spillage. The maximum belt loading capacity shall be 85% of theoretical loading capacity.

All conveyor equipment shall have a trip switch on both sides of the conveyor for emergency tripping.

PTY 4.3 Starting Equipment

Accelerating and braking forces shall be taken into account in the calculations of belt tensions and counterweights. Starting equipment shall be designed that the belt is not over-stressed when started under a full load.

PTY 4.4 Pulleys

The diameter of driving, driven and tripper pulleys as well as pulley shafts shall be as specified in SANS 1169 and shall be calculated for belt tensions between 100 - 150% of the maximum operating working tensions.

Pulley bearings shall be of the spherical roller bearing type with a L10_n life rating of 100,000 hours. Pulleys shall be of the fabricated type, bearings and pulleys shall be standardised.

PTY 4.5 Idlers

Outer surfaces shall be smooth and corners chamfered. Each assembly of roll, shaft, bearings, seals, etc. shall be concentric. Rolls shall be no less than 125 mm outside diameter.

Bearings shall be high-grade anti-friction type and shall have a minimum L10_h life rating of 100,000 hours. Idler bearings shall be of the life lubricated type. The bearings shall be protected by an effective sealing arrangement.

Troughing idler assemblies shall be of the three-roll type, in accordance with SANS 1313.

Parts exposed to dirt accumulation shall be designed and constructed for self-cleaning. Idler spacing shall comply with the spacing specified in SANS 1173. Return idlers shall be subject to the same basic design principles as the troughing idlers shall also apply to impact idlers.

At the loading points, closely spaced troughing idlers shall be used. The same provisions regarding bearings, etc. applicable to troughing idlers shall apply to impact idlers.

PTY 4.6 Loading and Transfer Points

Loading and transfer points shall be designed with the primary objective of reducing belt wear to a minimum and to eliminate spillage. Feed presentation from belts to equipment in parallel via trouserleg chutes will be central to the chute to avoid preferential feed to the equipment.

Feed presentation to the belt shall be central to avoid training problems. Chutes shall be designed to utilise the most suitable and economical wear resistant materials available and shall be made large enough to facilitate access for maintenance purposes.

Chute valley angles shall be a minimum of 60° from vertical.

New chutes and hoppers shall be provided with replaceable liners. All surfaces to be lined shall be covered over the full surface area that may be subject to wear.

Sideliners shall be made of not less than 4.5 mm thick VRN 500 plate. Impact liners shall be made of no less than 4.5 mm thick VRN 500 plate.

The liners shall be sized to facilitate ease of replacement and inter-changeability.

Chutes shall be provided with inspection hatches to allow for ease of inspection and block chute detection if required.

PTY 4.7 Take-ups

Gravity type take-ups shall be provided on all conveyors exceeding 40m between centres of the drive and tail pulley. Take-ups for conveyors shorter than 40m shall be screw type.

PTY 4.8 Walkways and Gantries

Walkways shall be open grid flooring suitably corrosion protected and shall be 750mm wide. All inclined walkways on conveyor gantries shall be of sloped construction and not stepped. Hand and knee rails shall be as per existing Beenup plant (or equivalent). All conveyors are to be supplied with only one walkway.

Where weightometers are to be installed on conveyors, a straight section of at least 6m will be allowed for the installation.


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

Where conveyors interface with buildings at ground level, external access to the gantry shall be allowed for without having to enter the gantry through the building.

PTY 4.9 Belting

Belting shall conform to SANS 1173. All splices shall be hot vulcanised.

PTY 4.10 Belt Cleaning

Scorpio type (or similar approved by the Engineer) primary and secondary scrapers shall be used for belt cleaning of all conveyors.

PTY 4.11 Return Belt Ploughs

All conveyors shall be fitted with Scorpio type (or similar approved by the Engineer) belt ploughs on return belts situated at the tail end.

PTY 4.12 Skirts

Skirts shall be provided at all feed points.

PTY 4.13 Deck Plates

Deck plates shall be provided at head, take-up and tail terminal points, including areas where conveyors cross access roads or buildings. All deck plates shall be of mild steel construction and painted to the paint specification requirements.

PTY 4.14 Protection

Suitable protection shall be provided for slippage and in the event of an obstruction causing the conveyor operation to be interrupted. The protection provided shall interrupt the operation of the conveyor thereby preventing damage to the conveyor belts.

A device incorporating a torque arm limit switch or a motor overload type shall not be considered. Intelligent motor protection relay type devices shall be accepted. A backup system shall be provided for in the design.

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

PTY 5 DESIGN SERVICE FACTORS

PTY 5.1 Service Factors Specified

Where special requirements exist, these shall be stated in the individual equipment specifications/data sheets and design service factors shall exceed these values.


PTY 5.2 Service Factors Unspecified

For continuous duty and heavy shock loads, service factors shall be individually considered and shall be approved. For medium duty and light shock loads, the following service factors shall apply. Consideration must also be given to the individual starting conditions in the selection of these components.

In selecting the capacity of electric motors, gears, gearboxes, power transmissions, couplings, pulleys, shafts, belts, etc., the design theoretical kilowatt ratings shall be increased by 20%.


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

In selecting the capacity of electric motors, couplings, shafts, vee-belts, and vee-belt drives, etc. for pumps, the designed theoretical kilowatt rating shall be increased by 25% to 50%, and for agitators (not stirrers) by 50%, to allow for possible overloading produced by pumps delivering larger quantities or at specific gravities higher than specified by the process requirement.

The factors of 25% to 50% and 50% shall be additional to the design factors used to obtain the theoretical kilowatt rating.

Machine Cut Gears: Service factors shall be as stated in the applicable British Standard Specification listed in clause 5.0.

PTY 5.3 Overload Capacities

Machinery and equipment, excluding motors, shall be designed to withstand a starting overload based on a minimum of 100% momentary overload, 50% overload allowance for 15 minutes and 25% overload allowance for periods not exceeding hours. Refer to individual equipment specifications for variations.

PTY 5.4 Transmission

Chain drives shall be in accordance with BS 228: 1984 – Transmission Roller Chains, Chain Wheels and Cutters.

Sufficient take-up allowance shall be provided on the motor mounting to take up two full chain pitches. Where take-up allowance is not possible due to fixed shaft centres, an adjustable chain wheel idler shall be incorporated.

All chain drives shall be adequately guarded and lubricated.

Unless otherwise specified, V-belt drives shall be standard sections and of the Space-Saver type. Belts shall be furnished in matched sets. Sheaves shall be accurately balanced and fitted with keyed 'Taper-Lock' bushings.

Drive motors shall be mounted on slide or pivoted bases allowing sufficient adjustment for correct belt tensioning according to the manufacturer's requirements. Bases shall incorporate jack screws with lock nuts. All V-belt drives shall be adequately guarded.

Gearboxes

Gearing shall be in accordance with the appropriate AGMA standards as revised. All gearing shall be machine cut to high commercial grade and shall be suitably heat treated before final machining.

Gearing not enclosed in an oil bath shall be adequately guarded and provision shall be made for safe lubrication.

Speed reduction units shall be of approved design and manufacture. Allowance for efficiency, cooling and lubrication shall conform to the manufacturer's recommendations.

Gearboxes shall be of rigid construction manufactured either from cast steel or fabricated from mild steel plate.

Gearboxes shall be dustproof and equipped with inspection covers, drain and filler plugs, breathers with suitable filters, oil level indicators or dip sticks and lifting lugs as required.

Fabricated gearboxes shall be guaranteed against distortion when in service.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Foot mounted gearboxes shall be assembled together with the prime mover on a common baseplate and accurately doweled in position. Shaft mounted gearboxes shall be mounted according to the manufacturer's recommendations.

All rotating equipment shall be clearly marked with an arrow showing the direction of rotation.

Bearings

Where required by design considerations, well lubricated non-ferrous bushings and bearings may be used.

Where phosphor bronze bearings are used the quality shall be to SAE 64 or equivalent. The supplier shall be required to provide details of specification number and analysis of metals used. This requirement shall also apply to the use of white metal.

Self-lubricating graphite or compound bearings shall not be used unless specifically requested.

For heavy duty and continuous service, plummer blocks shall be anti-friction spherical roller type with split housing rated to suite the application. All plummer blocks shall be fully self-aligning with one fixed and one floating type for each shaft assembly. With parallel shafts, inner ring adapter sleeves may be used.

For lighter duty, 80mm diameter and less, ball bearing plummer blocks may be used.

Unless otherwise specified, the basic rated life for all anti-friction bearings shall be 75,000 hours (L10_h as defined by SKF).

Plummer blocks shall be mounted on accurately machined sole plates equipped with lugs and jack screws with lock nuts for proper horizontal alignment.

All plummer blocks shall be installed such that the loads pass through the base and not the cap. Deviations from this arrangement for practical reasons shall be subject to approval and accompanied by design calculations.

Bearing housings shall be of cast steel, good quality cast iron or fabricated to specification and accurately machined where necessary. Housings shall be mounted on machined surfaces and located and fixed by permanent devices.

Design allowance shall be made for keyways and combined bending and torsion stress. Suitable fillet radii shall be provided at changes in diameter and shaft ends shall be chamfered. Changes in diameter and keyways shall not coincide.

Light duty shafting shall be hot rolled polished mild steel or cold rolled mild steel. Cold rolled shafting shall be subject to approval.

All shafts shall be metric or, if unavailable, imperial dimensioned shafts turned down at the bearing seats to the following diameters with tolerances appropriate to the particular bearings employed.

16	50	15
20	60	125
25	70	140
30	80	160
35	90	180
40	100	200

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

All shafts shall be supplied with keyseats and keys or feathers in accordance with BS 4235 Part 1: 1986 unless a fastening method other than by key is used. Any such proposed fastenings shall be submitted to the responsible Engineer together with design calculations for approval. All couplings shall be fitted with a removable guard unless the machine is already guarded in such a manner as to make a separate guard unnecessary.

Brakes shall be adequately sized for the load characteristics and heat dissipation.

PTY 6

LUBRICATION

Lubricants and lubrication fittings shall be in accordance with the following standards:-

- SANS 053:1972 : Viscosity Classification of Industrial Lubricating Oils
-
- SANS 344:1974 : Calcium Base Lubricating Grease
-
- SANS 351:1974 : Sodium Base Lubricating Grease
-
- SANS 406:1974 : Lithium Base Lubricating Grease
-
- SANS 1014:1974 : Multi-Purpose Lubricating Grease
-
- BS 1486:1982 : Lubricating Nipples Parts 1 & 2
-
- BS 1399 Parts 1 to 3:1970 : Rotary Shaft Oil Seal Units

All equipment supplies shall submit a specification of the lubrication requirements for their equipment, which shall include the following:-

- (i) Approximate quantities required for the initial fill.
- (ii) The expected rate of consumption of the lubricant and the recommended intervals for a complete change of lubricant.
- (iii) A lubrication chart indicating all lubricating points, periods for lubrication, oil and filter changes.
- (iv) A list of South African based suppliers of the recommended lubricants.

All plunger blocks shall be sealed against the ingress of moisture or dirt by means of a double lip seal or a Labyrinth seal.

Where wet or extremely dirty conditions occur, a flinger shall be used in addition to seals. For vertical shafts, a flinger shall be installed above the upper bearing seal. Lubrication of equipment, such as gearboxes, compressors, etc. shall conform to the recommendation of the equipment manufacturer.

All equipment, which normally contains lubricant and is despatched without such lubricant, shall be sprayed internally with a suitable moisture inhibitor to prevent deterioration during transport and storage. All machinery and equipment shall be checked for cleanliness and lubrication prior to testing or start-up.

Any special requirements for flushing and cleaning shall be stated by the manufacturer.

Such equipment shall carry clear legible tags indicating that there is no lubricant contained therein.

Gearing and chain drives shall have fully enclosed oil bath lubrication except where a low

Contractor

Witness 1

Witness 2

Employer

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Witness 2

peripheral velocity requires grease lubrication. Where the peripheral velocity of gearing exceeds 750 m/min, forced feed lubrication shall be provided.

All lubrication points shall be easily accessible from the normal maintenance/operating zones of the equipment. If necessary, lubrication points shall be extended by means of pipes or tubing to a location that is both convenient and safe for access during normal equipment operation.

PTY 7 BASEPLATES

Baseplates shall be designed to prevent undue deflection or failure under any conditions of loading likely to be encountered.

Baseplates shall be rigidly constructed, generally of cast steel or fabricated steel. For light duty, cast iron bases may be used.

Where practical, the prime mover and the gears, bearings, or other equipment shall be mounted on a common baseplate.

Mounting pads and baseplate feet shall be machined true and parallel. Allowance shall be made on the prime mover mounting pad for 5 mm maximum and 1 mm minimum shimming.

Where baseplates are fabricated they must be stress relieved before machining.

Baseplates shall incorporate jack screws with lock nuts to assist with aligning of the prime mover in relation to the gearbox, bearings or other equipment.

PTY 8 PLATEWORK

Where bins, chutes, liners and skirts are supplied as an integral part of mechanical equipment they shall be designed such that:-

- (a) They allow for the fast, smooth flow of material and avoid abrupt changes of direction which invite material build-up and subsequent plugging.
- (b) They have a minimum of throat constrictions.
- (c) They are firmly supported, manufactured from a minimum of 6 mm plate to SANS 1431 Gr. 300 WA and are suitably stiffened and supported to deal with loads and forces imposed on them.
- (d) Their valley angles are conservative and suitable for the materials handled.
- (e) Falling material does not impact directly on sensitive receiving equipment but rather on the sloping bottom of chutes.
- (f) Chutes and hoppers shall be provided with bolted flange connections in order to simplify installation and maintenance.
- (g) All nozzles to be fabricated from scheduled piping, wall thickness to match platework thickness. Flanges will be specified on the relative data sheets.
- (h) All platework and chutes to be trial assembled and match marked by the fabricator before delivery to site.
- (i) Bins, chutes, etc. and support structure (where required) shall be designed for a maximum static load when all full of mineral sand or slurry at a design bulk density as specified. Subassemblies or components shall be fitted with lifting lugs designed with adequate safety factors to lift the subassembly or components. Travelling members to be fitted (where required) to avoid distortion. Fabricator to supply spreader bars for components requiring such.
- (j) Where equipment such as scrapers, rappers and squeezers, spray units, etc. are housed within the chutes, they must be able to be removed without disturbing the main assembly.
- (k) Where material is in contact with the chutes, suitable liner plates shall be installed which shall be fastened by means of nib head countersunk bolts and waterproofed where necessary. Such liner plates shall be designed to allow for interchange ability and not to

exceed 30 kg in mass.

- (l) Equipment subject to abrasive slurry particle contact shall be protected against such abrasive materials by a minimum 6 mm thick natural rubber lining. All lining is to be returned around flange faces for sealing. Rubber lining shall be done in accordance with BS 6375-5: 1985 and SANS 1198: 1978.
- (m) The maximum deflection of any plate shall be less than 1 mm in 300 mm.

UNLESS OTHERWISE STATED ON THE DRAWING, LINER PLATES SHALL BE ARRANGED IN A BRICK PATTERN WITH A GAP OF NOT MORE THAN ONE LINERPLATE THICKNESS OR 10 mm (WHICHEVER IS THE LEAST) BETWEEN ADJACENT LINERS

PTY 9 DUCTING AND SHEET METALWORK (DUST COLLECTION AND VENTILATION)

Ducting, flanges, gates, etc. shall conform to details shown by the Industrial Ventilation Manual of Recommended Practice issued by the American Conference of Governmental Industrial Hygienists.

Ducting shall be checked after fabrication to ensure that:-

- No pin-holes or slag inclusions which would cause leaks during service are present in any welds.
- Inside diameters are to drawing, and ducts are concentric within 5 mm on diameter.
- Supports shall be designed and spaced so that sagging does not occur, allowing for a normal dust load, and shall be structurally adequate allowing for a dust filled plugged duct.
- After erection of ducting and the installation of dust extraction units, the complete system shall be tested, balanced and blast gates locked or tack-welded in place.
- All ducting and bends shall be manufactured from mild steel with a minimum thickness of 3 mm.
- All ducting shall have flanges welded to each end of each piece; such flanges shall be of a suitable thickness for the diameter but shall not be less than 3 mm.
- All flanged connections shall be complete with matching gaskets made from material suitable for the needs of the process.

PTY 10 WIRE ROPE, CHAINS AND FITTINGS

Wire rope, rope fittings, chains and chain fittings shall be in accordance with:-

- SANS 189:1984 : Short Link Chain for Lifting Purposes
- SANS 811:1974 : Thimbles for Wire Ropes
- SANS 812:1973 : Mild Steel Shackles
- SANS 813:1973 : Clamps for Wire Ropes
- BS 183:1982 : General Purpose Galvanised Steel Wire Strand
- BS 302 Parts 1 to 8:1987/89 : Wire Ropes for Cranes, Excavators and General Engineering Purposes
- BS 463 Part 2:1970 : Sockets for Wire Ropes (Metric Units)
- BS 2903:1980 : Forged Steel Hooks for Chain Slings, Blocks and General Engineering Purposes
- BS 6968:1988 : Guide for use and maintenance steel lifting chain and chain slings

All ropes, whether fixed suspension or for general use, shall comply with all relevant Acts and Statutory Regulations.

Hoist ropes and fittings shall comply with the regulations of the Mines and Works Act and the Machinery and Occupational Safety Act of the Republic of South Africa.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Rope fittings shall be securely attached to the ropes, preferably with terminal splicing standard spelter fittings or approved swaged fittings. All rope slings shall be tested to twice the required working strength. Spelter fittings shall not be used for high temperature applications. Where rope clips are specified, a minimum of three rope clips and a thimble shall be correctly fitted to make the connection.

All lifting tackle shall be supplied with test certificates.

Rope slings for general use shall be fitted with a metal tag indicating the safe working load. Sockets, thimbles, rigging screws, stretching screws, eyebolts, etc., shall have a safe working load of no less than that for the attached rope or chain. Wire rope and fittings that are a stationary part of a machine, and fixed guys shall be galvanized.

Chains shall comply with all relevant Acts and Statutory Regulations and shall be stamped indicating the safe working load.

PTY 11 FASTENERS

When bolting onto parallel surfaces, all nuts shall be fitted with plain parallel washers except where the machinery is subject to vibration or movement. Then, springs washers, nylon insert locknuts or tack welding shall be used as indicated by the design. Adjustable nuts (e.g. bearing take-up), castellated nuts with split cotter pins shall be used. For thread diameters of 10 mm and under, the use of tab washers is permitted.

High strength friction grip bolts shall be installed in accordance with:-

- SANS 094:1982 Bolted Friction-Grip Joints
- BS 3294 Part 1:1960 Structural Steelwork (Metric Units)
Precision bolts and nuts shall be supplied in accordance with:-
- SANS 136:1985 ISO Metric Precision Hexagon-Head Bolts, Screws and Nuts (Metric Units)
- SANS 646:1962 Precision Bolts, Screws and Nuts
Black bolts and nuts shall be supplied in accordance with:-
- SANS 135:1985 ISO Metric Black Bolts, Screws and Nuts Hexagon and Square (Metric Units)
- SANS 1143:1977 Mushroom and Countersunk Head Bolts and Nuts

Washers shall be supplied in accordance with SANS 1149 – Flat and Tapered Steel Washers. Black bolts shall be installed in accordance with the following assembly requirements:-

- (a) All bolt heads and nuts shall make contact, bearing on parallel plan surfaces perpendicular to the bolt axis.
- (b) A tapered washer shall be correctly positioned under the bolt head or the nut whenever the surfaces contacted are not parallel and perpendicular to the bolt axis. It shall be used against the sloping surface.
- (c) A flat washer or a tapered washer shall be used under the bolt head or nut, whichever is to be rotated during tightening operations. Washers shall be of adequate size and thickness to prevent their distortion, for any reason, during tightening.
- (d) After assembly and proper tightening, bolts shall project through nuts for a minimum distance of three (3) full threads.

When assembled, all HSFG bolted joint surfaces shall be free of dirt, loose scale, burrs and other defects that would prevent solid seating of the parts. All contact surfaces shall be free of oil, paint and lacquer or galvanising.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

All HSFG bolts shall be torqued using load-indicating washers of an approved type to ensure correct tension is achieved.
Plate liners, unless otherwise specified, shall be fitted with nib-headed countersunk bolts, and spring washers shall be used under the nuts.

PTY 12 OPERATION AND MAINTENANCE

Operation and maintenance of mechanical equipment shall be carried out strictly in accordance with the Equipment Manufacturer’s recommendations.

The Equipment Manufacturer shall supply Operation and Maintenance instructions which shall include full details and recommended frequencies of periodic maintenance checks, adjustments, running clearances and lubrication requirements.

PTY 13 PLANT LAYOUT

The following criteria shall apply for plant layouts:-

Buildings and conveyor transfer towers shall be positioned to make use of the natural slope of the contours at the site where possible, i.e. to minimise building heights and conveyor lifts.

Major mechanical equipment shall be positioned to facilitate removal with overhead cranes in the event of breakdown or maintenance. For smaller equipment, or where equipment cannot be reached by cranes, due to the nature of the plant layout, hoists and crawl beams will be used for maintenance purposes.

All sump pumps shall be suitably guarded for personal safety, as well as protection against the ingress of large objects.

The layout of the plant shall allow sufficient access for personnel engaged in operational and maintenance duties.

Platforms and walkways

Platforms and walkways shall be provided wherever access is required for regular inspection, lubrication or operation of machinery or equipment.

Walkways shall be clear 600 mm wide as a minimum.

Access to all valves, instruments and equipment lubrication points will be provided either from the ground floor or from a platform.

A minimum clearance of 2100mm shall be provided under equipment and steelwork.

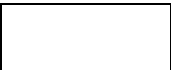
Stairways shall be provided rather than ladders except in extreme cases where space is not available or usage will be very infrequent.

Stairway slope shall be between 38° and 42°, maximum slope.

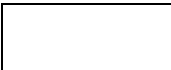
A walkway will be provided along one side of each belt conveyor.

Access ladders shall be provided to all crane bridges.

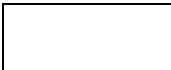
Vendors to specify maintenance clearance requirements for equipment supplied, these clearances to be incorporated into layouts.



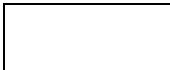
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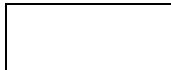
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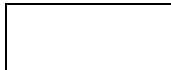
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Employer



Witness 1



Witness 2

PTY 14 ROTATING EQUIPMENT

The direction of rotation of all rotating non-reversing equipment will be clearly and indelibly marked on the casing or nameplate.

PTY 15 STAIRWAYS AND PLATFORMS

Stairways, platforms, access ladders and landings shall be provided as necessary and shall conform to relevant Building Regulations, or International Design Standard. Stairway slope shall be between 38° and 42° maximum.

PTY 16 HANDRAILS

Handrails shall be provided around all permanent openings, the edges of elevated platforms and access ways abutting edges to all internal side wall sheeting and walls, and to each stairway stringer and where required for safety.

PTY 17 EQUIPMENT ERECTION

All equipment shall be erected in accordance with the requirements of the Mechanical Erection Specification, and in accordance with Equipment Manufacturer's Installation Instructions.

PTY 18 EQUIPMENT NAME PLATES

All equipment shall have permanent nameplates of material suitable for corrosive conditions on which the equipment number and description shall be clearly marked. This will facilitate equipment identification during construction and commissioning.

PTY 19 OVERHEAD CRANES, LIFTING BEAMS AND HOISTS

Overhead cranes shall be sized for maintenance duties as apposed to installation duties. The overhead cranes will be sized for the heaviest regular maintenance lift required.

Lifting beams, hoists and cranes shall be provided for ease of servicing and removal of equipment. Adequate space shall be provided for rigging, removal and set down. Lifting beams and crane rails shall be designed to the relevant standards and test certificates shall be provided. Beams shall be stamped with the appropriate SWL. Lifting beams shall be equipped with a trolley from which to attach the hoists.

PTY 20 SAFETY

PTY 20.1 General

All mechanical designs shall ensure that the relevant regulatory and statutory requirements are met.

Guards

All rotating parts that are accessible shall be guarded. Shield guards or guard railing shall be provided at all belts, pulleys, gears, or moving parts.

Handrails, toeboards, and nonslip surfaces shall be provided on all elevated platforms, walkways, stairways and ramps.

All nip points shall be adequately guarded to prevent injuries



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Signs

Signs shall be provided to alert all personnel of the need for protective clothing such as steel capped boots, hard hats, and safety glasses.

Signs shall be provided where a specific exists, such as live conductors, high noise levels, low head clearance, trip hazards, hot surface prevails.

Clothing

Special footwear, masks and clothing for areas with high dust levels or surface area contamination shall be used.

Non-slip footwear, gloves, helmets, face protection, leggings and other protective equipment, as necessary, for work near high temperature materials shall be used.

Where there is a risk of flying chips or sparks, or where intense light is generated, eye protection shall be used.

Protective clothing and goggles shall be used in areas where highly corrosive materials are handled.

Emergency eyewash stations and safety showers shall be installed as required.

The mechanical design shall ensure that priority is given to all project safety and ergonomic aspects, including plant layout, constructability, maintainability and operability.

PTY 21 SPARES AND TOOLS

The Tenderer must submit on the appropriate schedule a priced list of spare parts which nit 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 available 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.

PTY 22 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

PTY 23 METAL PREPARATION AND CORROSION PROTECTION

Refer to Particular Specification PLQ: Corrosion Protection

PTY 24 COLOUR CODES

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

PTY 25 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

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

PTY 25.1 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 per these QCP’s.

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

PTY 25.2 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.

PTY 26 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.

In the case of gearboxes, they shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection

Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

After Initial Commissioning

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

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

PTY 27 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 / commissioning of the conveyor equipment required.

The tendered rates or sums shall cover the cost of drawings and instructions 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 as described 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.

The Tenderer shall include in his rates for coupling plates and the grouting thereof, nuts, bolts, washers and painting for the conveyor equipment to provide a complete working unit. New jacking bolts shall not be subjected to lengthening on Site. The Contractor shall repair all non-usable holes and pockets in the existing platforms. Allowance shall be made for the drilling of new holes, cutting new pockets in the concrete and coring through the platforms where necessary for their equipment offered.

<u>Item</u>	<u>Unit</u>
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Complete Access System	No
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The rate tendered shall include for the design, drawings, quality assurance, materials, corrosion protection, labour, transport etc for the provision of the access bridge walkways when specified.

Complete Conveyor System	No
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The rate tendered shall include for the design, drawings, quality assurance, materials, corrosion protection, labour, idlers, pulleys, skirts, deck plates, transport etc for the provision of the conveyor system when specified.

Should the Contract require the removal of existing equipment, differentiation between the various sizes of equipment to be removed shall be made. The costs shall include for the electrical disconnections, lifting equipment, labour, etc. to successfully remove the unit measured.

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

C3.4.3.2 PARTICULAR SPECIFICATIONS FOR ELECTRICAL AND ELECTRONIC WORKS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.4.3.2 PARTICULAR SPECIFICATIONS FOR ELECTRICAL & ELECTRONIC WORKS

List of applicable Particular Specifications:

ERMU	:	Ring Main Units
EMVSG	:	Medium Voltage Switchgear
EMSS	:	Miniature Substation
EMCC	:	Motor Control Centres
EPLC	:	Programmable and Logic Controllers
PSL	:	Site Lighting
ESCA	:	Supervisory Control and Data Acquisition (SCADA)
ECIS	:	Control Instrumentation Systems
EG&M	:	General and Miscellaneous
ESPL	:	Small Power and Lighting Installations
ESLS	:	Site Lighting System
ESGS	:	Standby Generator System
EELP	:	Earthing and Lightning Protection
EMCA	:	Multicore Cables and Earthwires

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

The following Particular Specifications for electrical works will be applicable to this Contract:

EMVS	MEDIUM VOLTAGE SWITCHGEAR	5
EMSS	MINIATURE SUB STATIONS	49
EMCC	MOTOR CONTROL CENTERS AND DISTRIBUTION BOARDS	67
EPLC	ELECTRICAL/ELECTRONIC: PROGRAMMABLE LOGIC CONTROLLERS	93
ESCA	SCADA - SUPERVISORY CONTROL AND DATA ACQUISITION	114
ECIS	CONTROL AND INSTRUMENTATION SYSTEMS	126
EG&M	GENERAL AND MISCELLANEOUS	138
EELP	EARTHING AND LIGHTNING PROTECTION	175
ESPL	SMALL POWER AND LIGHTING INSTALLATIONS ON BUILDINGS AND STRUCTURES	189
EMCA	MULTICORE CABLES AND EARTHWIRES.....	206
ESLS	SITE LIGHTING SYSTEM	228

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June 2025

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

EMVS MEDIUM VOLTAGE SWITCHGEAR

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



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EMVS MEDIUM VOLTAGE SWITCHGEAR
EMVS 1 SCOPE

As specified in the Project Specifications.

EMVS 2 STANDARDS

The medium voltage switchgear shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply:

Table 1: Applicable Standards

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
SANS 10142-2	Code of Practice for the wiring of Premises (Medium voltage)
NRS 006	Switchgear metal enclosed
NRS 008	Enclosure for cable terminations in air
NRS 029	Current Transformers
BS 142	Electrical Protection relays
BS 162	Switchgear
BS 2631	Switchgear
BS 3938	Current Transformers
BS 3941	Potential Transformers
SANS 556	Switchgear
SANS 1371	Bushings
SANS 1433-1	Terminal blocks having screw and screwless terminals
SANS 1433-2	Flat push-on connectors
SANS 1411-1	Materials of insulated electric cables and flexible cords: conductors
SANS 1091	National colour standards for paint
SANS 1186	Symbolic safety signs
SANS 1195	Busbars
SANS 1371	Bushings
IEC 62271-200	Internal Arcing test
IEC 62271-100	Pressure withstand test for gas-filled compartments
IEC 62271	Making and breaking capability of switching devices
IEC 62271-1	High-Voltage switchgear and controlgear – Common specification
IEC 60529	Verification of IP coding
IEC 62262	Verification of IK coding
ANSI / IEEE	American National Standards Institute ANSI / IEEE
C37.04	Standard Rating Structure for AC HV Circuit Breakers
C37.06	Preferred Ratings for AC HV Circuit Breakers
C37.09	Standard Test Procedure for AC HV Circuit Breakers

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Standard No.	Description
C37.010	Application Guideline for AC HV Circuit Breakers
C37.011	Application Guide for TRV for AC HV Circuit Breakers
C37.012	Application Guide for Capacitance Switching
C37.11	Requirements for Electrical Control
C37.20.2	Standard for Metal-Clad and Station-Type Cubicle Switchgear
C37.55	Conformance Testing Procedure of Metal-Clad Switchgear
C57.10	Requirements for Instrument Transformers
C57.13 Requirements for Instrument Transformers	Requirements for Instrument Transformers
47	Guide for Surge Withstand Capability Tests
NEMA	National Electrical Manufacturers Association (NEMA)
CC1	Electrical Power Connectors
SG-4	Standards for Power Circuit Breakers
SG-5	Power Switchgear Assemblies
IEC 60051-1	Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories Part 2: Special Requirements for Ammeters and Voltmeters

EMVS 3 STANDARDS AND DRAWINGS

All materials used shall satisfy the relevant SANS specification and may only deviate from it upon a definite instruction in this specification. The successful Tenderer shall ensure that he possesses the latest edition of the relevant SANS specifications as listed in this specification.

EMVS 4 PRE-MANUFACTURER

EMVS 4.1 Structural Drawings, with critical dimensions

- Arrangement;
- Plan, front view, and elevation section views;
- Required clearances for opening doors and for removing breakers;
- Conduit or cable trays entrance locations and dimensions for both top and bottom entrance;
- Bus bar locations and configurations;
- Incoming and outgoing power cable terminator positions;
- Anchor bolt locations;
- Grounding connections;
- Weight of equipment;
- Elementary Three-Line Diagrams.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMVS 4.2 Three line diagrams, with function numbers used throughout

- Instrument transformers;
- Relays;
- Meters and meter switches;
- Breakers and other pertinent devices;
- Schematic Diagrams;
- Schematic diagrams shall be furnished for the electrically-operated breaker / relay control scheme;
- Each schematic diagram shall show device and terminal block terminal numbers for customer connections;
- Provide control switch development tables.

EMVS 4.3 Detailed Connection (Wiring) Diagrams

- Approximate physical location of all items in each unit;
- All wiring within each unit;
- All interconnecting wiring between units;
- Identification of all terminals, terminal blocks, and wires;
- Provide one set of drawings shipped with the switchgear for start-up use.

EMVS 4.4 Material List

- An electrical bill of material list shall be furnished listing the quantity, rating, type, and manufacturer's catalogue number of all equipment on each unit.

EMVS 4.5 Installation, Operating, and Maintenance Instructions

- Installation, operating, and maintenance instructions shall cover switchgear, breakers, relays, meters and devices requiring installation, programming and / or maintenance;
- The breaker operating mechanism shall be front-accessible, and all routine maintenance shall be performed with the breaker in an upright position. The interrupters shall be completely sealed requiring no interphase barriers. Breakers shall be designed for easy insertion, removal and transport on flat indoor surfaces;
- A breaker lift truck shall be supplied with the switchgear.

EMVS 5 BASIC CONSTRUCTION

The switchgear assembly shall consist of metal-clad, free-standing, vertical, dead-front steel structures containing circuit breaker compartments and circuit breakers, primary bus system, ground bus system, auxiliary compartments and transformers, protection and control devices, control bus (as required) and connection provisions for primary, ground, and control circuits.

The basic structure will be of modular construction and fabricated from steel specified in the project specification.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All the parts of the switchboard shall be able to withstand any mechanical stresses, which may develop out of normal duty or during maximum short circuit conditions without any damage or distortion to any part.

The switchboard shall be equipped with arc venting off venting system and front doors and panels shall be reinforced with special door locks to withstand explosion forces associated with maximum short circuit conditions.

The instrument and relay panel shall form an integral part of the switchboard with all the instruments and protection relays flush mounted.

The switchgear shall be designed so that future units can be added to each end (unless coupled to other equipment). A removable plate will cover any unused openings in the side of the gear.

Panels shall be manufactured from steel as specified in the Project Specification with a minimum thickness of 2 mm.

All the bolts used to bolt the different parts of the panel together shall be provided with jack nuts or another approved method to secure the nuts. No Self-Tapping Screws Shall Be Allowed. All the bolts and nuts visible from the outside shall be chromed and of the dome type.

EMVS 5.1 Compartments

The switchgear system shall be comprised of the following discrete modules, arranged for each vertical section:

- Circuit breaker compartments;
- Low voltage instrument compartments;
- Bus and cable compartments;
- Draw-out Auxiliary compartments (PT, CPT, Fuse, etc.)

EMVS 5.2 Circuit Breaker Enclosure

The circuit breaker enclosure shall include stationary support bushings and primary contacts for engagement with the circuit breaker or ground and test (G&T) device. Standard bushings shall be made of porcelain capable of supporting the weight of the current transformers. Primary contacts will be made of copper and designed to accept round, tulip style connectors.

EMVS 5.3 Ground Bus

Copper ground bus shall be provided for the entire length of the switchgear. It shall be equipped with a solderless connector for copper cable at each end. The ground bus shall be accessible in the cable compartment, and shall have connection points in each switchgear section for workmen's grounds. The ground bus will be connected to the breaker frames and will ground the draw-out circuit breaker in and when traveling in between the connected and test positions.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMVS 5.4 Bus Bars

The main bus compartment shall be separated from the other compartments by an steel barrier and shall fully enclose the main bus. The main bus compartment shall be accessible from the rear through the cable compartment. Main bus ratings shall match the highest rated circuit breaker continuous current ratings and comply with ANSI / IEEE temperature rise requirements.

Bus bars shall be copper and shall be completely isolated and coated with an epoxy insulation that is flame retardant, non-hygroscopic and high-dielectric, except at bolted joints. The bus shall be mechanically braced for the close and latch rating of the breaker having the highest interrupting rating within each assembly. All bolted bus joints shall be Standard – silver-plated with. The bus connections to the circuit breakers shall match the breaker rating. Bus supports shall be flame retardant, track resistant Standard - porcelain.

Bus joint cover boots shall be manufactured from moulded PVC and shall be removable and reusable for field inspection and maintenance. Taping of bus joints is not acceptable.

The shape of the bus bar shall be full round edge. The main bus shall not be tapered.

Bus bar connections shall be mechanically secured with reusable fastening devices that shall maintain adequate pressures at the joints within the operating temperature range of the switchgear.

The bus bars and support systems shall be designed to withstand the forces created during short circuit conditions at the rated momentary and short-time (conditions of the highest rated circuit breaker and as specified in the Project Specifications. Supports shall be made of Standard - porcelain.

An insulated, rigid, copper riser bus shall be provided from the circuit breaker / switchgear primary disconnects to a cable compartment location to allow cable termination lug connections. Riser bus connections to bus duct shall be rigid. Cable termination bus arrangement shall allow for primary cable stress cones or potheads. Connections to roof entrance bushings shall include flexible straps from the rigid bus to the roof bushings.

The design shall be adaptable for top or bottom primary entrance arrangements which will be specified in the Project Specifications.

EMVS 5.5 Equipment

Bar type / zero-sequence current transformers, lighting arresters, surge capacitors, stationary control power transformers, ground sensors, or other auxiliary equipment shall be mounted in the cable compartments.

Rear extension shall be provided to accommodate additional equipment and power cable if required.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Control switches, instruments, meters, position indicating lights, protective relays, etc. shall be in a separate compartment from the circuit breaker unless specifically allowed by the Project Specifications. All other monitoring devices such as CT's and limit switches may be located within other compartments. Low voltage compartment door mounted devices shall be mounted on the front of the switchgear panels and arranged in an approved, logical, symmetrical manner. In those cases where there is not enough space on the door of the instrument compartment, the manufacturer shall advise for either increasing the size or extension shall be installed to mount metering, protection, and control devices.

EMVS 6 CURRENT AND FAULT RATINGS AND TEMPERATURE LIMITATIONS

All current carrying parts shall have normal, fault make, withstand and break ratings, as specified in the Project Specifications.

EMVS 7 INSULATION

All the Medium Voltage current-carrying parts shall be fully insulated or otherwise screened off and spaced in such a way that the basic insulation level shall be maintained under all working conditions.

Allowance shall be made for the easy dismantling of the bus bar connections when the switchboard is extended.

EMVS 8 ISOLATING CONTACTS

Isolating contacts shall be provided for circuit breakers and potential transformers. They shall be of the self-aligning type and must not transfer mechanical stresses. All accesses to the isolating contacts shall be equipped with mechanical shutters being operated by plugging-in or withdrawal of the circuit breaker or potential transformer. Facilities shall be provided to lock the shutters in the closed position.

Shutters for bus bar contacts shall be painted red while those for cable contacts shall be painted yellow. Shutters for double bus bars shall be marked according to the bus bar position.

EMVS 9 POWER CIRCUIT BREAKER

EMVS 9.1 Type

The power circuit breakers shall be electrically operated, 3-pole, draw-out type, with vacuum interrupters and a magnetic actuator operating mechanism with capacitor stored energy. The power circuit breaker shall be provided with self-aligning line-side and load-side disconnecting devices.

The circuit breaker mechanism shall have a life of 100,000 no-load operations.

Wheels shall be provided on the bottom of the circuit breaker for easy floor rolling after the breaker is removed from the frame. Circuit breakers that require a separately purchased floor rolling truck assembly are not acceptable.

EMVS 9.2 Rating

The rating of the circuit breaker shall be not less than the rating as specified in the Project Specification.

Test certificates issued by an independent test laboratory shall be submitted to prove the fault rating of the circuit breaker. Failure to submit these certificates may lead to the disqualification of a Tender.

EMVS 9.3 Draw-out Mechanism

The circuit breaker will be provided with an integral racking mechanism. Circuit breakers utilizing switchgear mounted racking mechanisms separate from the circuit breaker are not acceptable.

The draw-out mechanism shall hold the breakers rigidly in the **CONNECTED** (primaries and secondary's engaged), **TEST** (primary contacts disconnected and shutter closed, but control contacts engaged) and **DISCONNECTED** (both primary and secondary contacts disengaged) positions, with the door closed.

The secondary contact plug shall automatically disconnect when the breaker is moved from the **TEST** to the **DISCONNECTED** position. A fully automatic, self-aligning, secondary disconnecting device shall be provided to act as a disconnect for the secondary connections between the circuit breaker and the switchgear.

The disconnecting device shall be positioned and constructed as to not expose the operator to live parts. The secondary disconnect shall connect automatically when the circuit breaker is racked into the test and connected positions

The female portion of the disconnect system shall reside in the breaker compartment, so that energized contacts are recessed and remain "touch safe". To guarantee the integrity of operating personnel, it shall not be required to open or keep opened the door of the circuit breaker compartment after the breaker has been locked in the disconnected position to be able to rack the breaker or connect the secondary contacts, Circuit breakers that require manual connecting or disconnecting of the secondary contacts are unacceptable.

The breakers in the upper compartment and lower compartment shall be held captive in the cubicle by means of a latching mechanism, even in the disconnected position. Removal of the circuit breaker shall be by means of unlatching the mechanism and pulling the circuit breaker onto a lift truck. Cell must have a lip for proper sealing of the door and to prevent ingress of dirt and other contaminants. Circuit breakers that require rail extensions for circuit breaker removal are not acceptable.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMVS 9.4 Interlocks and Safety Mechanisms

Interlocks shall be provided which will prevent connecting the breaker to, or disconnecting it from the bus stabs unless the breaker is OPEN (tripped), assuring proper sequencing and safe operation. The close springs of the circuit breaker will automatically discharge when the breaker is released from the cell by pulling in on the truck latch assembly. Provisions shall be made for the addition of optional KIRK KEY interlocks, as shown on project data sheets and the single line diagram.

Apart from any other interlocking or safety mechanism, the following mechanical interlocks shall be provided on every circuit breaker:

- Interlock to prevent the circuit breaker from being plugged in or isolated or to be inserted in the spouts when the circuit breaker is in the "closed" position.
- To prevent the circuit breakers from being closed unless it is properly in the "Service", "Isolated", "Test" or "Earthed" position or unless it is totally withdrawn from the fixed part of the panel.
- To prevent the circuit breaker from being closed in the "Service" position unless the secondary circuits on the circuit breaker and panel had been properly coupled.
- Interlock to prevent accidental contact with any live parts.
- Interlock to prevent access to the high voltage fuses of the potential transformer unless the transformer has been fully isolated.

EMVS 9.5 Electrical Interlocking

Electrical interlocking where necessary shall be specified in the Project Specifications.

EMVS 9.6 Control voltage and trip voltage

The breaker motor charging range shall be as specified in Project Specifications. The trip voltage shall be as specified in Project Specifications. The close voltage shall be (as specified in Project Specifications).

Close and trip circuits for each breaker shall be separately fused. Fuse blocks shall be dead front, pull-out type, which provides the control power disconnecting means.

EMVS 9.7 Closing of a circuit breaker

The circuit breaker shall be provided with a magnetically actuated mechanism which shall use a flux-shifting device with integral permanent magnets. It also shall incorporate an electronic controller and a capacitor for energy storage. The circuit breaker mechanism shall be capable of 100,000 no-load operations. The breaker shall be virtually maintenance free, except for minor lubrication. The circuit breaker shall be capable of operating in three cycles which means smaller power cables, lower construction costs, and improved system quality. The mechanism shall be completely front accessible and maintainable by removing the faceplate. Breakers that require lifting to access the mechanism under the carriage are unacceptable. It shall be possible to

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

program the electronic controller to react in three different ways upon loss of control power: 1) trip the circuit breaker immediately, 2) trip the circuit breaker with a delay, or 3) remain in the closed position, which will be specified in the Project Specifications.

The circuit breaker shall have the capability of accepting AC and DC as control power as specified in the Project Specifications.

The closing mechanism shall have a facility for local operation. Facilities for remote closing shall be provided for all Medium Voltage switchgear.

EMVS 9.8 Tripping of the circuit breaker

The circuit breaker shall be equipped with a D.C. shunt trip coil of the specified voltage as well as facilities for mechanical tripping by hand; the latter being suitably protected against accidental tripping and shall be clearly and indelibly marked.

The trip coils shall operate satisfactorily at 50 % under voltage.

EMVS 9.9 Indicator mechanisms

Positively driven mechanical indicators shall be supplied on the circuit breaker to indicate clearly whether the circuit breaker is in the "closed" or "open" positions. Springs charged and discharged indication shall also be given.

EMVS 9.10 Accessories and auxiliaries

The circuit breaker shall be complete and equipped with all the accessories and auxiliary contacts required for the successful operation as well as the specified indications and interlocking.

All the spare auxiliary contacts shall be wired to spare secondary plug contacts.

A fully automatic, self-aligning, secondary disconnecting device shall be provided to act as a disconnect for the secondary connections between the circuit breaker and the switchgear. The disconnecting device shall be positioned and constructed as to not expose the operator to live parts. The secondary disconnect shall connect automatically when the circuit breaker is racked into the test and connected positions. The female portion of the disconnect system shall reside in the breaker compartment, so that energized contacts are recessed and remain "touch safe". To guarantee the integrity of operating personnel, it shall not be required to open or keep opened the door of the circuit breaker compartment after the breaker has been locked in the disconnected position to be able to rack the breaker or connect the secondary contacts; Circuit breakers that require a manual secondary contact connecting plug are not acceptable.

The breaker shall have a mechanism device to indicate open or closed position, and spring charge status. Only the correct status flag for any single function shall be visible. Additionally, the breaker shall have a 5-digit, non-resettable operations counter.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMVS 10 EARTHING FACILITIES AND EARTH BAR

The switchboard shall have integral facilities to earth cable circuits via the circuit breaker and the necessary auxiliary gear shall be provided to earth the busbars. The earthing of busbars shall preferably only be possible on the incoming supply panels.

Earth bars, earth blocks, cable boxes and glands shall be bonded with the panels by using brass bolts and nuts unless otherwise specified. Not more than two earth conductors will be permitted on a single connection point.

The earth bar shall be in an acceptable position to allow for earthing of cables and shall have sufficient connection points to take all earthwires.

All metal-clad instruments, meters, relays etc., mounted on hinged doors as well as the doors themselves shall be earthed.

Draw-out gear shall have an early-make-late break earthing arrangement which closes or breaks automatically when a circuit breaker truck is pushed-in or drawn-out.

EMVS 11 CURRENT TRANSFORMERS

Current transformers shall comply with BS 3938, 1973, and shall have a ratio and be suitable for the purpose as specified in the Project Specifications.

The primary windings of current transformers shall have the same short circuit rating as the associated circuit breaker unless special approval had been obtained. The primary windings may not have a cross-sectional area of less than 70 mm² copper.

Air insulated current transformers shall have a minimum audible corona discharge level of 8kV at 50 Hz to earth.

The secondary circuit of each set of current transformers shall be earthed at one point by means of a removable link.

Where specified summation current transformers shall be of the same accuracy class as the other current transformers in the same circuit.

Nameplates shall be located on the CT housing and information provided. The CT winding shall terminate on a screw type terminal on the CT housing and shall be wired to shorting terminal blocks.

Each current transformer shall have a 1-ampere secondary and a primary rating shall be specified in Project Specifications.

Each current transformer shall have a short-circuiting device (shorting type terminal blocks). The first termination of each current transformer shall be at the short-circuiting device terminal blocks where the ground connection is also made.

Low voltage ring type CT's will be bushing-mounted, located behind the shutters and accessible from the front. Bushing design will accommodate up to four standard accuracy CT's per phase (two on the bus side and two on the load side) for all ratings.

EMVS 12 POTENTIAL TRANSFORMERS

Potential transformers shall be of the 3-phase type and shall be coupled to either cable or the busbar side of circuit breaker panel as required. The transformers shall comply with all the relevant standards as specified in the document.

The potential transformers shall have a ratio of primary voltage to 110 V AC.

Both the primary and secondary windings shall be connected in star and such that with the exception of the inherent phase-angle-error, there shall be no phase displacement between the primary voltage and the induced secondary voltage.

Disconnection of potential transformers shall preferably be obtained by withdrawal of the transformers.

Suitable mechanical shutters shall be provided to shut off the access to all the fixed primary plugging contacts automatically when the transformer is withdrawn. Provision shall be made to lock the shutters in the close position with padlocks. Furthermore it shall be possible to lock the transformer in the "Service" position with padlocks.

The "Yellow" line of each transformer shall be earthed by means of a bolted link.

Potential transformer shall be designed to withstand the Basic Impulse Level (BIL) of the switchgear. Potential transformers shall always be fused. Potential transformers shall be mounted on a draw-out unit in an auxiliary enclosure, which disconnects them from the primary circuit safely. Potential transformers shall be supplied in accordance with Project Specifications.

Potential transformers shall be mounted in a separate draw-out compartment (truck assembly) and so arranged that the unit can be withdrawn from the operating position via a racking device with the door closed. In the withdrawn position, the fuses shall be completely disconnected from service and all exposed parts shall be visibly grounded.

The potential transformers compartment shall incorporate extension rails to allow changing fuses and general maintenance without the need to take the truck assembly completely out of its compartment.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Potential transformers shall be connected to the line or load via solid copper rod, bus or shielded cable.

An impact resistant glass-viewing window shall be on the front of the potential transformer door.

Each transformer shall be protected with current-limiting primary fuses, and shall be designed to withstand the basic impulse level of the switchgear.

Each transformer shall have a 110-volt AC secondary, accuracy classification shall be detailed in the Project Specification.

EMVS 13 POTENTIAL INDICATORS

Potential indicators consisting out of three neon-indicating lamps shall be provided. The neon lamps shall be energised via capacitor bushings on the cable side of the relevant circuit breaker.

One lamp shall be provided for each phase and they shall be marked clearly and indelibly "Cable Live".

The point where the indicating lamp is bonded to the bushing shall be permanently earthed via a resistor to avoid dangerous voltages

Threshold of indication of voltage presence below 45% of nominal three-phase system voltage is in line with IEC 61243-5 and IEC 61958.

Withstand voltages and withstand fault currents are in line with IEC 60694.

Resistance to moisture ingress tested according to IEC 60099-4.

EMVS 14 CABLE END BOXES

Cable boxes shall be suitable to accommodate the cable or cables for each circuit as specified. This applies not only to the number of cores, size and conductor material, but also to the type and construction of the cables.

Cable boxes shall be complete with the necessary clamps, tapes, glands, compound, terminating and other accessories. If heat shrink cable ends are specified then the end boxes shall be provided complete with the necessary wooden cable clamps and all accessories.

Mechanical cable glands for control and auxiliary cables shall be suitable for PVC/PVC/SWA/PVC type cables. The armouring shall be clamped firmly to ensure a reasonably good electrical connection and to prevent the cables from being pulled out easily. Each gland shall be complete with a neoprene shroud and one locknut.

3CR12 unpainted cable gland plates shall be provided for proper earthing of cable glands.

EMVS 15 CONTROL, INSTRUMENT AND RELAY PANELS

All protective relays, auxiliary relays, indicating instruments, recording instruments, indicating lights, transducers, etc. shall be housed in the low voltage compartment unless specifically specified in the Project Specifications. The low voltage compartment shall isolate the above equipment so that additional arc flash protection is available. Relays and instruments shall be provided and wired as specified in Project Specification.

Protective relays and test devices shall be semi-flush mounted. The relays shall be so arranged that they can be tested in position on the panel and readily withdrawn from the panel for inspection or replacement.

No relay or trip coil may be permanently connected to the positive pole of a D.C. supply. Protective relays shall be equipped with separate alarms and trip contacts.

Where auxiliary relays are required for alarm or indication facilities, these relays shall be of the series type.

The characteristic curves of overload and earth fault relays shall unless being specified to the contrary be of the inverse definite minimum time type with a three seconds time lag at 10 In and a time multiplier setting of 1,0. The time multiplier shall have a setting range between 0,05 and 1,0. The overload setting range shall preferably be between 50 % and 200 % while the earthfault range shall either be between 10 % and 40 % or 20 % and 80 %, all these ranges shall be obtained in 7 equal steps. Relays shall be dust proof and only external repair shall be possible.

Front panel mounted female socket for hard wired remote switching of circuit breakers shall be provided on each circuit breaker. The “chicken switch” shall be equipped with a matching male type plug top.

The relays shall support IEC 61850 Editions 1 and 2, including IEC 61850-9-2 LE for less wiring and supervised communication. IEEE 1588 V2 for high-accuracy time synchronization and maximum benefit of substation-level Ethernet communication. Shall also support Modbus, DNP3 and IEC 60870-5-103 communication protocols

All equipment, relays, etc., for protection systems shall comply with BS 142 and 3950 and their amendments.

All the relays and instruments shall be flush mounted with only the control handles, push buttons and the faceplates being visible.

Protection relays shall be provided as specified in Project Specification.

EMVS 15.1 Typical Incomers Equipment

- a) Large graphical display showing customizable single line diagram, accessible either locally

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- or through an easy-to-use web-browser-based HMI 3-phase overcurrent protection (time and instantaneous);
- b) Ground overcurrent (time and instantaneous);
- c) Directional overcurrent as well as phase-voltage and frequency-based protection;
- d) Multi-shot reclosing (If specified);
- e) High set instantaneous;
- f) Ammeter per Phase, demand and peak demand ammeters;
- g) Event recording;
- h) Accumulation of breaker interrupting duty;
- i) Continuous self-checking;
- j) Cable Theft Monitor, Intelligent Vibration Sensor, CT Strap and all accessories.
- k) Minimum of RS-485 communications ports for remote terminal connection.

EMVS 15.2 Typical Transformer Equipment

- a) Large graphical display showing customizable single line diagram, accessible either locally or through an easy-to-use web-browser-based HMI 3-phase overcurrent protection (time and instantaneous);
- b) Ground overcurrent (time and instantaneous);
- c) Directional overcurrent as well as phase-voltage and frequency-based protection;
- d) Multi-shot reclosing (If specified);
- e) High set instantaneous;
- f) Ammeter per Phase, demand and peak demand ammeters;
- g) Event recording;
- h) Accumulation of breaker interrupting duty;
- i) Continuous self-checking;
- j) Cable Theft Monitor, Intelligent Vibration Sensor, CT Strap and all accessories.
- k) Temperature and Bucholz alarm / trip indication on HMI Display.
- l) Minimum of RS-485 communications ports for remote terminal connection.

EMVS 15.3 Typical Motor Protection Equipment

- a) Large graphical display showing customizable single line diagram, accessible either locally or through an easy-to-use web-browser-based HMI 3 Motor differential protection, thermal overload protection, motor start-up supervision and frequency protection (time and instantaneous);
- b) Ground overcurrent (time and instantaneous);
- c) Directional overcurrent as well as phase-voltage and frequency-based protection;
- d) Multi-shot reclosing (If specified);
- e) High set instantaneous;
- f) Ammeter per Phase, demand and peak demand ammeters;
- g) Event recording;
- h) Accumulation of breaker interrupting duty;
- i) Continuous self-checking;
- j) Cable Theft Monitor, Intelligent Vibration Sensor, CT Strap and all accessories.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- k) Shall be equipped with RTD/mA module to be used for various protection and monitoring purposes in motor applications;
- l) RTD/mA inputs and 4 mA outputs
- m) Minimum of RS-485 communications ports for remote terminal connection.

EMVS 16 TREATMENT AND PAINTING OF METAL PANELS

All metal parts shall be treated before painting in accordance with the requirements of standard corrosion protection specifications and the appropriate coating system shall be selected for the specific application.

Powder coating for Indoor Panels shall be done to the following standards:

Substrate	Steel
Pre-Treatment	Vapour Degrease & Immersion Zinc Phosphate
Type of Powder	Nylon Modified Polyester Powder
Film Thickness	70 microns

Type of Test	Test Standard	
Salt Spray	ASTM B-117 -73, BS 3900 Part F4	500hrs
Cross Hatch	2mm Crosshatch BSN ISO 2409	
Impact	ISO 6272, DIN 55669, BS 3900 E13	
Flexibility	ISO6860 (Conical Mandrel)	
Pencil Hardness	ISO 15184: 1998	3H

Powder coating for coastal region panels shall be done to the following standards:

Substrate	Steel
Pre-Treatment	Vapour Degrease
Type of Powder	1st Coat Zinc Rich Powder, 2nd Coat Polyester Powder
Film Thickness	120 microns

Type of Test	Test Standard	
Salt Spray	ASTM B-117 -73, BS 3900 Part F4	1000hrs
Cross Hatch	2mm Crosshatch BSN ISO 2409	
Impact	ISO 6272, DIN 55669, BS 3900 E13	
Flexibility	ISO6860 (Conical Mandrel)	
Pencil Hardness	ISO 15184: 1998	3H

EMVS 17 INSTRUMENTS

Indicating instruments shall comply with IEC 60051-1. Instruments shall be of the 2,5 accuracy class.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All instruments shall be flush mounted. Ammeters shall be equipped with suitably rated saturation current transformers.

EMVS 18 TEST BLOCKS

Test blocks shall be mounted on the front of the panels to enable the connection of external instruments in the potential and current transformer circuits complete with terminals and links for the short circuiting and bridging of circuits. Where more than one test block is installed on a panel, it must be clearly and indelibly labelled to indicate the relevant circuits.

EMVS 19 FUSES AND LINKS

Fuses and links of the withdrawable cartridge type shall be installed in the control and protection circuits as specified.

Cartridges for 15A fuses shall be green, for 5A and 1A fuses they shall be black while links shall be white. Fuses and links in closing circuits shall be subsidiary to those in trip circuits.

EMVS 20 TERMINALS

Terminals may be of the bolted type otherwise they shall be of rail mounted clamp type.

All types of terminals and their insulation shall have a minimum comparative creep index of 500 to BS 3781.

a) Bolt type terminals

The bolts shall be such that they cannot turn around in the insulation. The minimum diameter of bolts shall be 6mm.

Current may not be conducted by the bolts through the insulation.

A maximum of two connections per bolt shall be allowed. Locknuts or spring washers shall be used to prevent loosening of nuts by vibration.

Terminals having a potential higher than 50V shall be insulated.

a) Clamp type terminals

These terminals shall be not less than 8 mm wide.

Screws and connectors shall be electroplated to prevent corrosion. The connectors shall be such that the screws will not loosen due to vibration. Current carrying parts shall be of serrated silver plated copper or brass. Only one connection shall be allowed per connector. For more connections the number of terminals shall be increased and bridge pieces shall be used.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

EMVS 21 MONITORING, CONTROL AND WIRING

Voltage free contacts shall be provided for circuit breaker spring charged indication and position indications

Control circuits shall be wired with 600/1000V grade PVC insulated cables complying with SANS 1507. These cables shall have at least 7 strands with a total cross-section of not less than 2,5mm².

Inter panel connection PVC covered conductors shall be protected by means of non-conducting grommets at panel through holes to prevent damage to conductor outer sheath.

EMVS 22 NUMBERING OF CONDUCTOR ENDS

Every conductor end whatsoever, with the exception of AC power cables at any terminal shall be numbered. The alpha numeric numbering and the colour of the wiring shall be in accordance with - BS 158 - 1961.

These numbers shall correspond with those on the circuit diagram and shall consist of ferrules situated behind the cable lug. It shall not be possible to remove the ferrule without damaging it or cutting off the lug.

EMVS 23 CONNECTION OF CONDUCTOR ENDS

All conductors whatsoever shall be connected at terminals by means of lugs and/or ferrules suitable for the specific conductor and terminal.

EMVS 24 LABELS AND INSCRIPTIONS

The standard labels on equipment regarding the manufacturer, type, class, rating etc.

Engraved laminated plastic labels shall however be provided to indicate the main circuits as well as the functions of relays, fuses, links, lights and selector and control switches. These labels shall be fixed with screws, bolts or rivets.

The proposed wording of labels as well as those for flagging or alarm relays in alarm panels shall be in English and submitted to the Engineer for approval.

EMVS 25 BATTERIES AND CHARGER

Battery cells shall be of the Lithium type with reserve requiring a minimum of maintenance.

The batteries shall be housed in a steel cubicle in such a way that the testing, maintenance and filling of the cells can be carried out conveniently. The centre point of the battery shall be earthed via a high resistance earth fault alarm relay.

The battery charger shall be of the constant voltage type with the charging current being limited by the battery characteristics. The minimum charging current shall be variable to allow for the battery requirements as well as any permanent load being connected to the battery.

The charger shall be suitable for use on a 230V plus/minus 10%, 50Hz. A.C. supply and equipped with an A.C. switch and fuse as well as a minimum charge current adjuster.

On the D.C. side the charger shall be equipped with a charge current meter, voltmeter, test button and a test load resistance.

A gland plate in such a position that access to the cables is obtained from the bottom shall be supplied for one supply and three outgoing cables and shall be manufactured from 3CR12 unpainted stainless steel.

Terminals shall be wired for monitoring of battery status, supply voltage and any trip condition on a remote monitoring system.

EMVS 26 MAINTENANCE TOOLS EQUIPMENT

a) Spare fuses and lamps

One spare fuse shall be provided for each fuse used on the switch gear.

Two spare lamps shall be provided for each lamp used on the switch gear.

The spare lamps and fuses shall not be used by the Contractor.

a) Tools, Tool boxes and brackets

At least two spring charging handles, operating handles and door keys as well as one remote operating chicken switch shall be provided for each substation.

Wall mounted brackets shall be provided for carrying the manual operating handles and test jumpers.

If special tools are required, a complete set of finished case-hardened spanners and special wrenches to fit every nut and bolt on the equipment supplied shall be provided under this contract. Any special tools or keys that may be required for effecting adjustments of parts as well as all standard earthing and test equipment, shall also be provided.

These tools shall be accommodated in a suitable, neat, and properly designed; wall constructed steel equipment cabinet with tool positions marked. The cabinet shall be capable of being locked by means of a padlock.

A fully detailed list of tools shall be supplied before delivery.

The tools shall not be used for the erection of the contract works.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All tool boxes and testing equipment brackets shall be properly fitted against substation walls in suitable positions.

EMVS 27 TEST EQUIPMENT

The following is understood under test equipment and shall be supplied as part of the contract for every switchboard.

- a) Plug-in contacts to establish a connection with the 11 kV isolating contacts on the switch gear for the purpose of pressure and injection testing as well as cable fault finding.
- b) An extension cable with plugging contacts and sockets to establish a connection between a circuit breaker and the secondary circuits on the fixed part of the switch gear for the checking of the secondary circuits.

EMVS 28 HANDBOOKS

Prior to the commissioning of any equipment, the contractor shall submit to the Engineer four sets of handbooks giving full particulars of all the gear. Under full particulars the following shall be understood:

- a) Switchgear technical descriptions and specifications.
- b) Erection and commissioning instructions.
- c) Operating instructions.
- d) Descriptions of the operation, setting, adjusting and maintenance of the gear.
- e) A parts list with illustrations for the correct identification and ordering of parts.

A draft handbook shall be submitted to the Engineer in advance for approval.

EMVS 29 INSTALLATION AND ERECTION OF SWITCHGEAR

The switchgear panels shall be properly aligned, erected, plumbed, bolted together and fixed onto the floor.

If the floor is not level, suitable packing shall be used to level the switchboard.

Each individual panel shall be levelled before the panels are bolted together.

The panels shall be assembled and erected strictly in accordance with the manufacturer's instructions, which shall be issued to the Installation Contractor by the manufacturer.

Switchgear trucks shall move freely and shall be properly aligned.

EMVS 30 EARTH RESISTANCE SURVEY

The Contractor will be responsible to have an earth resistance survey carried out on site by a specialist in this field, to be approved by the Engineer. The test shall be done on the undisturbed site, i.e. before earth works, trenching, building etc. commence.

The Engineer shall attend the survey. The Contractor shall inform the Engineer in good time when the test is scheduled to take place. If it is done without him or his representative being present, the test shall be repeated in the Engineer’s presence at no additional cost.

The results of this survey will be used to adjust the earthing system as specified if necessary, on the basis of the quoted rates.

Payment for the services of the specialist shall be by the Contractor.

EMVS 31 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection and all safety clothing prescribed by the Engineer.

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

Following test will be minimum:

- The control circuits shall be operated at the normal voltage and current for proper operation of circuit breakers, circuit breaker simulators, switches, contactors, interlocks, etc.;
- Instruments shall be energized from the low voltage winding of the potential transformers and the low current winding of current transformers. Where practical, each instrument shall be operated through its range of voltage, current and/or phase angle and frequency to produce deflections over the entire scale;
- The ratio and interconnections of all potential transformers shall be functionally checked to verify conformance to the electrical drawings and electrical bills of material.
- Relays shall be tested by applying rated current and/or voltage as required to determine proper performance characteristics. Each relay shall be tested to determine its proper operation in itself and also in the total overall circuit performance;
- A static circuit check shall be performed for auxiliary switches, external circuit connections and parts of circuitry that have not been checked or cannot be checked functionally. The

- devices shall be checked for mechanical function and for conformance to the schematic and wiring diagrams;
- After all electrical tests and mechanical checks have been completed and corrections have been signed off, the following dielectric tests shall be performed:
 - a) Each power bus shall be given a high voltage withstand test from phase to phase and phase to ground at the specified voltage, frequency and time duration indicated in the Standard C37.20.
 - b) Control wire shall be given a high voltage withstand test from wire to ground at the specified voltage, frequency and time duration with reference to the proper standard.

The cost of all tests must be included in the tender price.

EMVS 32 PERFORMANCE TESTS & TESTING

On completion of erection and installation the Contractor must carry out the following tests, where applicable, in addition to any other tests:

Before commissioning

- a) Cable Insulation test.
- b) Earth continuity test.
- c) Test for correct operation of control gear, setting of overload protection equipment, etc.

On completion of installation and putting into proper operation all the plant and equipment, the Contractor will be required to make suitable arrangements for the testing of all plant and equipment supplied under this Contract and running the plant for at least one week, during which time he shall also train all the operators in the correct running of the plant. He shall also explain the maintenance manuals to the operator during this time.

The entire cost of testing, including supply of test equipment, must be borne by the Contractor and an adequate allowance for such tests must be made in the Tendered price.

EMVS 33 PROTECTION SETTINGS

The Contractor will be responsible to have protection setting calculation done by a specialist in this field, to be approved by the Engineer. The protection settings shall allow discrimination between protection settings of supply authority switchgear, plant incomer and distribution system medium voltage switchgear protection settings and protection settings shall be done by the specialist and demonstrated for correct operation by means of secondary injection test procedures.

The Engineer shall attend the test demonstration and the Contractor shall inform the Engineer in good time when the test is scheduled to take place. If it is done without him or his representative being present, the test shall be repeated in the Engineer's presence at no additional cost.

Short circuit analysis and coordination study "Short Circuit Analysis/Coordination Study" shall be completed and submitted with switchboard submittal to confirm interrupting rating of submitted equipment is adequate for the point of application in the electrical distribution.

Payment for the services of the specialist shall be by the Contractor.

EMVS 34 DEFECTS LIABILITY PERIOD

During this period the Contractor must visit the Site at least three times, say 1, 6 and 12 months respectively after the Commissioning Date, to inspect and check all the plant supplied and installed by him for proper operation and to adjust where necessary, and to satisfy himself that the regular maintenance of the plant is being carried out correctly and in accordance with the written instructions supplied by him. The Contractor shall make sufficient provision in the contract price for these visits.

EMVS 35 MEASUREMENT AND PAYMENT

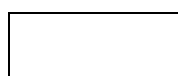
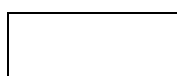
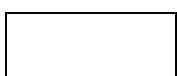
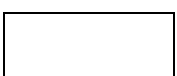
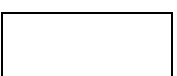
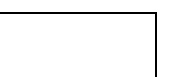
Measurement and payment will be done in accordance with the methods stated below:

EMVS 35.1 Design, Drawing and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For medium voltage switchgear installation, design information shall include, but limited to, the following:

- Manufacturer's product data of metal enclosed switchgear and all related components.
- Dimensioned drawings of metal enclosed switchgear showing accurately scaled basic units including, but not necessarily limited to, auxiliary compartments, unit components and combination units.
- Schematics and wiring diagrams for metering and controls.
- Furnish, upon request, manufacturer's certification of rating of the basic breaker, switch and fusing components and the integrated metal-enclosed interrupter switchgear assembly.
- Short circuit analysis and coordination study "Short Circuit Analysis/Coordination Study" shall be completed and submitted with switchboard submittal to confirm interrupting rating of submitted equipment is adequate for the point of application in the electrical distribution.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide design drawings and design information for medium voltage switchgear	Sum
(b) Provide operating all maintenance manuals and "as-built" drawings as specified	Sum
(c) Allowance for short circuit analysis and coordination study and protection setting calculations	Sum

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMVS 35.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For medium voltage switchgear, the rate tendered shall be for the complete medium voltage switchgear and shall include, but not limited to, the detailed in this particular specification. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2 .

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of medium voltage switchgear	Sum
(b) Supply and delivery to site of charger and battery unit	Sum

EMVS 35.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

Install of switchgear shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the switchgear complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of switchgear but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of medium voltage switchgear	Sum
(b) Installation of charger and battery unit	Sum
(c) Earthing resistance survey	Sum
(d) Protection setting calculations and setting of protection relays	Sum

EMVS 35.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, testing apparatus, instruments and equipment, any/all equipment required for testing purposes and to prove performance, any/all temporary works, and compilation of final commissioning report.

Prior to energization, check switchgear for continuity of circuits and for short circuits. Each switchgear line up bus shall have its insulation resistance tested after the installation is complete

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



except for line and load side connections. Tests shall be made using a Megger Earth Tester or equivalent test instrument at a voltage of not less than 1000 volts dc. Resistance shall be measured from phase to-phase and from phase to-ground.

Following completion of the construction work and prior to final acceptance testing, the overcurrent ground fault protection systems shall be field-tested with a test-set checking the calibration of each relay and reset to the manufacturer's settings for both current and time. Contractor shall furnish a time current coordination study. Submit the results on log-log paper showing coordination with downstream devices. Contractor shall submit three copies to the Engineer. Contractor shall notify the Engineer one week in advance of the test so that the Engineer may be present. Coordinate final overcurrent and time setting with the supply authority switchgear, plant incomer and distribution system.

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of medium voltage switchgear, inclusive of charger and battery unit	Sum

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

ERMU ELECTRONIC RISING MAIN UNIT

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ERMU 1 RING MAIN UNITS (RMU)

ERMU 1.1 Scope of Works

This specification includes the manufacturing, delivery, transport, handling, protection, storage, installation, successful commissioning and upholding during the Defects Liability Period.

The applicable scope of the works covered by this section shall be defined in the Variations and Additions to the Standard and Particular Specifications Section C3.4.2 and relevant Tender drawings.

This specification is for the supply and delivery of metering and non-metering type MV Ring Main Unit's (RMU) for the provision of MV (11kV) bulk electricity supplies and section switches. The Ring Main Unit's, with the exception of Item 3 is to be provided complete with weatherproof enclosure and plinth, suitable for installation in locations with public accessibility.

The following types are specified (the types required are listed in the Project Specifications):

- a. Item 1: Metering type MV RMU for supplying transformer loads of up to 4 MVA.
- b. Item 2: Non-metering type MV RMU for supplying transformer loads of up to 500 kVA.
- c. Item 3: Non-metering type MV RMU for supplying transformer loads of up to 2 MVA.
- d. Item 4: MV Three-way switch.
- e. Item 5: MV Four-way switch.

ERMU 1.2 Service Conditions

Unless otherwise specified in the Technical Schedules in the following sections of this document, all equipment offered shall be suitable for use under the following service conditions. Installation shall be in normal indoor conditions in accordance with IEC 60694.

Table 2: Service conditions

Ambient temperature	-10°C to 50°C
Altitude	1000 to 1600m
Average humidity	Not exceeding 95%
Lightning conditions	Moderate / Severe
Level of atmospheric pollution	High

ERMU 1.3 Standards

All equipment manufactured and supplied must comply with NRS 006, SABS and the following relevant international standards;

- 62271-1 HV Switchgear & Control gear – Part 1: Common Specifications
- IEC 62271-200 HV metal-enclosed switchgear
- IEC 62271-100 Circuit breakers
- IEC 62271-102 Earthing switches
- IEC 62271-105
- 60265-1 Switch disconnectors.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- 60044-1 Current transformer
- 60044-2 Voltage transformer
- 60125 Protection relays
- 60470 Contactors
- 60282-1 Protection fuse
- SABS 1874 – 2001 up to and Metal-clad Ring Main Units for rated voltages above 1kV and including 24kV.
- SABS 1885 – 2001 including 36kV- Metal-clad switchgear for rated a.c. voltages above 1kV and General Requirements and Method of test.
- SABS IEC 61330-1995 High-voltage/low-voltage prefabricated substations (enclosure design).

ERMU 1.4 Compliance to Statutory Regulations

- a. All units must comply with the Occupational Health and Safety Act, (Act 85 of 1993).
- b. The supplier shall be fully responsible for the design and satisfactory performance of the RMU's in service.

ERMU 1.5 Qualifying Tests

ERMU 1.5.1 Type Tests

Type tests are intended to establish design characteristics. They are normally only made once and repeated only when the design, components or the material of the unit are changed. The results of the type tests are recorded as evidence of compliance with design requirements.

- a. For the RMU, type tests as specified in SABS 1874 shall be carried out.
- b. For the VT, type tests as specified in SANS 60044 shall be carried out.
- c. For the enclosure, type tests as specified in SANS 61330 shall be carried out.

ERMU 1.5.2 Routine Tests

- a. Routine tests are intended to prove conformance of units to specific requirements and shall be made on every unit. These tests shall be non-destructive.

ERMU 1.5.3 Manufacture's Test Certificates

- a. The successful supplier shall submit Test Certificates carried out prior to despatch from the manufacturer's works. (Tests to be in accordance with standard requirements).

ERMU 2 GENERAL MECHANICAL AND STRUCTURAL CONSTRUCTION

All Ring main units with or without metering shall be supplied in an ARC Proof metal enclosed cubicle with Top Vent.

- a. The RMU unit shall be **fully arc proof metal enclosed (Top Vent)**, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Each unit is to be made of a cubicle sealed for life with SF₆ gas and contains all medium voltage components sealed off from the environment. If a system requires use of several units a separate extension of the busbar shall form a system with a common busbar.

- b. The overall design of the switchgear shall be such that front access only is required. It shall be possible to erect the switchboard against a substation wall or mounted on a precast plinth, with MV cables being terminated and accessible from the front.
- c. The unit shall be constructed from at least 3 mm thick stainless steel sheets. The design of the units shall be such that no permanent or harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers.
- d. The cubicle shall have a pressure relief device. In the case of an internal arc, the high pressure caused by the arc shall be released by the device. The hot gases shall be exhausted from the top of the cubicle. A controlled direction of flow of the hot gas shall be achieved in order to avoid injury to the operator.
- e. The switchgear and control gear shall have the minimum degree of protection (in accordance with IEC 60529);
 - IP 67 for the tank with high voltage components
 - IP 2X for the front covers of the mechanism
 - IP 3X for the cable connection covers
- f. The switchgear shall have an optional possibility to be extendable in either direction.
- g. Each unit shall be supplied with an operating handle.

ERMU 2.1 Panel (Module) Description

Incoming cable module

- a. The incoming cable module shall consist of an SF₆ cubicle housing an on-load switch disconnector and an earth switch.
- b. The busbars and all electrical connections shall be located inside the tank.
- c. The operating shafts for the switches shall have rotary seals where they enter the SF₆ cubicle.
- d. The operating mechanisms shall be located outside on the front of the SF₆ tank.
- e. Cable bushings shall be located on the front of the SF₆ cubicle in a separate cable compartment.
- f. Access to the cable bushings shall be in the lower part of each module.
- g. Covers containing the mimic diagram and having a degree of protection IP2XC shall be used to close the front of the panels.

ERMU 2.2 The Circuit Breaker Module (Outgoing Feeder)

- a. The circuit breaker module shall consist of a Vacuum / SF₆ cubicle housing a circuit breaker unit and a disconnector earth switch.
- b. The circuit breaker shall be of the type and rating as indicated in the Project Specifications.
- c. An integrated (self-powered) relay and associated CT's shall be used for tripping of the circuit breaker during fault conditions.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- d. Busbars and all electrical connections shall be located inside the tank.
- e. The operating shafts for the switching devices shall have rotary seals where they enter the SF6 cubicle.
- f. The operating mechanisms shall be located outside on the front of the SF6 tank.
- g. Cable bushings shall be located on the front of the SF6 cubicle in a separate cable compartment.
- h. Access to the cable bushings shall be in the lower part of each module.
- i. Covers containing the minimum diagram and having a degree of protection IP2XC shall be used to close the front of the panels.

ERMU 2.3 Circuit Breakers

- a. Circuit breakers shall be of the vacuum/SF6 type.
- b. Circuit breaker ratings shall be as specified in the Project Specifications.
- c. The circuit breaker main circuit shall be connected in series with a three-position disconnecter-earth switch.
- d. The operation between circuit breaker and disconnecter earth switch shall be mechanically interlocked.

ERMU 2.4 Busbars

- a. The busbars shall comprise of 3 single phase copper busbars and the connections to the on-load cable modules and the circuit breaker module
- b. The busbar shall be fully integrated inside the SF₆ cubicle.
- c. The busbars and the circuit connections to the busbars shall have normal current ratings suitable to the application and shall be calculated by the Contractor.
- d. Busbars shall be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.
- e. The use of cabled sections in busbar runs (e.g. to provide connections to bus-couplers) is not acceptable without the written approval of the Electrical Engineer.
- f. The temperature rise of busbars, busbar joints, busbar connections and breaker plug-in contact shall not exceed the figure laid down by BS 159 when carrying rated current, due account being taken of temperature rise correction for altitude.

ERMU 2.5 Rating of Switchgear

ERMU 2.5.1 Voltage Rating

- a. The MV switchgear shall be suitable for safe operation on the specified system for all operating conditions. The working voltage for the building substation shall be specified in the **Project Specification**.
- b. There shall be no audible corona discharge under working conditions. This requirement shall be taken to be complied with only if the audible corona extinction voltage, phase-to-earth, or phase-to-phase, is not less than 125% of nominal system voltage. Compliance may be conceded if it can be shown that any discharge below the specified level takes place at points remote from all dielectric materials and cannot cause their deterioration.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ERMU 2.5.2 Fault Capacity

- a. The switchgear shall have the fault current ratings at nominal system voltage as specified in the **Project Specifications**.
- b. The contractor shall be required to verify the system fault level, and submit the details to the Electrical Engineer before commencing with manufacture.
- c. Testing shall be done on an entire switch unit, complete with circuit breaker, potential transformer and condenser bushings where applicable, current transformers, busbars, shutters, cable boxes and if necessary, such parts of adjacent panels as are required to support the busbars and present a complete unit for testing.

ERMU 2.5.3 Impulse Rating

- a. The switchgear shall have an assigned impulse rating as specified in the **Project Specifications**, supported by recent test certificates proving successful testing, using a standard 1/50 microsecond voltage wave, on identical units, manufactured in the factory from which an order would be executed.
- b. The complete RMU shall withstand a one minute power frequency voltage, of 2.2 times the rated voltage.
- c. Should reasonable doubt exist as to the validity of test certificates submitted, for example by virtue of modifications made to the switchgear, the Electrical Engineer may direct that a further certificate(s) be obtained on a sample unit(s) manufactured under the Contract at the expense of the Contractor. Such tests shall be carried out by a recognized testing institute and (at their discretion) in the presence of the Electrical Engineer.

ERMU 2.6 Electrical Requirements

ERMU 2.6.1 Basic Impulse Level (BIL)

- a. The rated impulse voltage withstands level (BIL) and the rated short duration power frequency withstand r.m.s. voltage (1 minute) of the RMU's 95kV and 28kV respectively as indicated in Table 1 of SANS 1874.

ERMU 2.6.2 Earthing

- a. The maximum earth fault current is 10kA for 1 second.
- b. The RMU shall have a copper earth bar with a cross sectional area of at least 70mm² that is accessible from all compartments. All earthing connections shall be provided with M12 bolts and nuts.
- c. The earth terminals of all equipment within the RMU, including the RMU shall be connected to the main earth bar of the RMU.
- d. The RMU enclosure shall be bonded to the earth bar. All RMU enclosure sections shall be bonded to one another.
- e. The RMU earth bar shall be accessible from the front. All equipment shall be shall be bonded to the RMU earth bar by 70mm² copper conductor.
- f. All earthing copper bars shall be enclosed with separate metal covers which shall be secured to the RMU with a bracket or earth braid, to prevent theft.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ERMU 2.7 On-Load Cable Disconnecter

- a. The on-load cable disconnecter shall be a combination of a switch-disconnector and an earth switch.
- b. The arc-quenching medium shall be SF₆ gas.
- c. The on-load cable disconnecter shall have three positions, namely:
 - Open
 - Closed
 - Earthed

ERMU 2.8 Earth Switch

- a. Earth switches shall be rated equal to the switchgear rating.
- b. Earth switches shall be of the quick-make type.
- c. Earth switches shall be operated from the front of the cubicle by means of a removable handle.

ERMU 2.9 Circuit Breaker Module

- a. The circuit breaker module shall be a combination of a circuit breaker and an earth switch.
- b. The circuit breaker and earth switches shall be mechanically interlocked.
- c. The arc-quenching medium shall be SF₆ gas.
- d. The circuit breaker shall have three positions, namely:
 - Open
 - Closed
 - Earthed

ERMU 2.10 Operating Mechanisms

- a. All operating mechanisms shall be situated in the mechanism compartment behind the front covers outside the SF₆ tank.
- b. The mechanism for the on-load cable disconnecter and the earth switch shall operate both devices via one common shaft.
- c. The mechanism shall provide independent manual operation for closing and opening of the disconnecter, independent closing of the earth switch and dependent opening of the earth switch.
- d. The mechanism for the vacuum circuit breaker (VCB) and disconnecter-earth switch shall operate the VCB and the disconnecter-earth switch via two separate shafts.
- e. The mechanism for the VCB shall have stored spring (kinetic) energy and shall provide independent manual operation for closing and opening of the VCB.
- f. The mechanism shall have a self-powered relay with associated CTs and/or remote tripping device.
- g. The mechanism for the disconnecter-earth switch shall provide independent manual operation for closing and opening of the disconnecter, independent closing of the earth switch and dependent opening of the earth switch.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ERMU 2.11 Electrical Bushings

- a. The bushings shall be made of cast resin with moulded electrical conductor in the centre.
- b. A screen shall be moulded into the bushing. This screen shall act as the main capacitor supplying voltage indicators.
- c. The bushings shall be sealed by O-rings and fixed to the cubicle by a common supporting bracket.

ERMU 2.12 Mechanical Bushings

- a. The mechanical bushings are the interface between the switches inside the cubicle and the mechanism outside.
- b. The mechanical bushing shall have a rotating shaft, which is connected to the shaft of the switch and to the corresponding shaft of the mechanism.
- c. The rotating shaft shall be sealed by a double set of radial simmering gas seals.
- d. O-rings shall provide the fixed sealing of the bushings.

ERMU 2.13 Front Covers

- a. The front cover shall contain the mimic diagram of the main circuit with the position indicators for the switching devices
- b. The voltage indicators shall be situated on the front covers.

ERMU 2.14 Position Indicators

- a. The position indication of the switching devices shall be visible through the front cover and be directly linked to the operating shaft of the respective switching devices.
- b. Mechanical position indicated shall be used.
- c. The following three positions shall be clearly visible for each of the different switching devices:
 - Open
 - Closed
 - Earthed

ERMU 2.15 Voltage Indication

ERMU 2.15.1 Neon Lights

- a. Where specified, three voltage-indicating neon lights – one for each phase – shall be provided to indicate whether the cable side of the circuit is energized.
- b. The neon lights shall be energized from condenser bushings on the cable side.
- c. It is the responsibility of the Contractor to ensure that the rating of the condenser bushings are sufficient to supply the imposed load on the bushings and to provide clear indication by the neon lights, even on the remote control boards, to the full approval of the Electrical Engineer.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- d. The Contractor shall state the make and type of condenser bushings used and the type of dielectric used for the manufacture of the bushings, and the certified 1/50 microsecond impulse strength of the bushings.
- e. Each neon light shall be shunted by a suitable resistor or non-linear resistor located immediately adjacent to the condenser bushings to prevent dangerous potentials appearing in the event of lamp failure and to protect the lamps against voltage surges.

ERMU 2.15.2 On-Load Cable Disconnecter

- a. A separate set of voltage indicators (neon lights) shall be situated on the front cover of the respective modules.
- b. The voltage indicators shall be used to indicate the cable voltage of each incoming module.
- c. Identification of the phases shall be achieved by labels indicating L1, L2 and L3 on the front of the voltage indicators.
- d. The voltage indicator shall satisfy the requirements of IEC61243.

ERMU 2.15.3 Circuit Breaker Module

- a. A dedicated analogue voltmeter shall be situated on the front cover of the circuit breaker module to indicate the busbar voltage.
- b. Voltmeters shall be of the suppressed zero type and scaled to the approval of the Electrical Engineer with the normal operating voltage reading indicated in red.
- c. A voltage selector switch shall be provided having four positions marked "OFF", "R-B", "Y-B" and "R-Y" so that the voltage across any two lines may be indicated or the voltmeter may be disconnected from the circuit.
- d. The voltmeter shall be supplied via voltage transformers that shall be connected to the main busbars via primary fuses.
- e. All voltage transformers shall comply with IEC 60186.
- f. Voltage transformers shall be of dry type, with ratings and ratios as specified in the Technical Schedules.
- g. Voltage transformers in cubicles shall have dimensions according to DIN 42600, Narrow type.

ERMU 2.16 Cable Compartment

- a. It shall be possible to terminate a minimum of two single core MV cables per phase.
- b. The access to the compartment shall be possible by removing the cable cover, bolted to the main frame.
- c. Removable steel covers shall close the cable compartments.
- d. Arc proof cable covers shall be available as an option.
- e. Each module shall have a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall shall be fitted to divide the cable compartment from the rear side of the switchgear.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- f. In case of an arc inside the tank, followed by the opening of pressure relief device, the partition wall shall prevent the hot gases flowing out from the pressure relief to enter the cable compartments.
- g. All covers shall be removable.

ERMU 2.16.1 Power Connection

- a. The cables shall be installed below the mimic front cover.
- b. The medium voltage cables shall be connected to the unit through electrical bushings
- c. The bushings shall be fitted with a capacitor of approximately 15 pF. This capacitor shall be the primary capacitor used in the capacitive voltage divider, which shall form part of the permanent cable voltage indicator.
- d. At the bottom of the cable compartment an earth bar system shall be fitted. This system shall be made of copper with a minimum cross-sectional area of 120 mm²
- e. In each compartment the earth bar shall be fitted
- f. The main SF6 tank shall be connected to the copper earth bar

ERMU 2.17 Interlocking

- a. The mechanism for the on-load cable disconnecter shall provide a built-in mechanical interlocking system to prevent the following operations:
 - Closing of disconnecter switch when the earth switch is close
 - Closing of the earth switch when the disconnecter switch is in the closed position.
- b. The mechanism for the circuit breaker unit shall provide a built-in mechanical interlocking system to prevent the following operations:
 - Closing of the circuit breaker when the earth switch is closed.
 - Closing of the earth switch when the circuit breaker is in the closed position.
- c. In addition, an interlocking device that allows access to the fuses only when the earth switch is in the earthed position and opening of the earth switch is only possible when the fuse cover is closed and secured.

ERMU 2.18 Auxiliary Equipment

ERMU 2.18.1 Current Transformers

- a. Current transformers shall be of dry type, with ratings and ratios as specified below.
- b. The low voltage metering current transformers shall be of the multi-ratio type, with ratios 100/200:5 for item 1 and 100/50:5 for item 2 and 3. The current transformers shall comply with SANS 60044-2
- c. All primary connections and all current transformers shall have a short time current rating corresponding to the rated breaking capacity of the switchboard.
- d. No CT wires shall be joined under any circumstances.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- e. The “Limits of Temperature Rise of Windings” specified in Table 1 of BS 3938 for the condition of rated current and burden, shall apply instead when the current transformer carries 150% of rated current and 225% of rated burden, continuously.
- f. Magnetisation characteristics ($V_{kp} - 10$ curves) and secondary winding resistance referred to 75°C shall be provided for all protection and metering current transformers. The following will specifically be required:
 - For Class TPS CT's, the excitation current shall be measured with V_k applied to the secondary winding.
 - For Class 5P and 10P CT's, the excitation current corresponding to the rated accuracy limit factor
 - The secondary winding resistance referred to 75°C
 - For all metering CT's, tests for accuracies as specified in BS 3938, Clause 9.1 are required.
- g. Current transformers used for metering purposes shall be of Class 0.5 accuracy and rated for a burden of 15 VA in accordance with BS 39378 (SABS IEC 60185)
- h. The metering CTs shall be designed for early saturation and the Contractor shall state the saturation factor applicable.
- i. Current transformers required for ammeter indication only, shall be Class 0.5 metering type for a burden of 15 VA.
- j. All current transformer secondary connections shall be brought out to fully accessible terminal blocks and shall be clearly marked.
- k. Duplicate rating plates to BS 3938 (SABS IEC 60185) for all CTs, shall be fitted in an accessible position on the relevant switchboard housing (e.g. where hinged doors are fitted to relay cubicles, the inside of such a door is an ideal position for mounting duplicate rating plates.)

ERMU 2.18.2 Voltage Transformers

- a. Where specified, three-phase voltage transformers shall be provided for connection to the main busbars.
- b. The voltage transformer shall be oil-immersed, or totally encapsulated in epoxy resin, using recognized vacuum filling techniques.
- c. The voltage transformer shall have an output of 50 VA per phase, be of Class 0.5 accuracy to BS 3941 (SABS IEC 60186) and shall be complete with fuses in the primary circuit and MCBs in the low-voltage circuit.
- d. The medium voltage fuses shall be accessible only when the voltage transformer is fully isolated from the primary plug-in contacts.
- e. The secondary voltage output shall be 110V between phases. The secondary wires of the VT outputs shall not be joined.
- f. The primary and secondary windings of the VTs shall be connected such that there shall be no phase displacement between corresponding primary voltages and secondary voltages, except for inherent phase angle errors.
- g. Isolation of a VT shall be achieved by complete withdrawal of the VT assembly from its primary isolating contacts.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ERMU 2.18.3 Low Voltage Compartment

- a. Necessary terminal blocks and wiring etc. shall be placed behind the front cover of each module.
- b. Further additional low voltage equipment shall normally be contained in the low voltage compartment. In particular:
 - Terminal blocks
 - Wiring for interconnections between units connecting the auxiliary cables
 - Instruments
 - Protection relay
 - Metering devices
 - LV fuses etc.

ERMU 2.19 Wiring

- a. Multi-stranded flexible copper conductor 600/ 1000 V grade solid dielectric insulated single core wiring shall be used for all wiring.
- b. All wiring shall be number feruled at both ends of each conductor. The numbering method employed shall conform to the system laid down in Annexure A of NRS 003-1.
- c. All CT and VT circuit wiring shall have a cross sectional area of 2.5mm², with red, white, blue according to the relevant phases and black for the neutral.
- d. All internal signal wiring and control wiring shall have a cross sectional area of 1.5mm² with grey wire for DC wiring and black wire for AC wiring.
- e. All wires shall be provided with pre-insulated lugging, which shall be of the hooked flat blade (spade) type for terminal connections and ring ferrules for CT connections. For relay terminal connections ring type or hooked flat blade types shall be used, alternatively where space limitations are experienced, boot lace ferrules could be considered if approved in writing. Push-on lugs shall not be considered.
- f. All wiring shall be placed in adequately supported trunking or looms with 20% spare capacity per wire-way. Consideration shall be given during the design stage to temperature rise within trunkings or looms. The designed shall ensure that excessive temperature build-up does not occur within trunking or looms during normal operation of the system.

ERMU 2.20 Metering Compartment

- a. A metering compartment for electricity meter and thermal maximum demand indicator of 400mm wide and 200mm deep shall be supplied.
- b. The metering compartment shall be separate and independent from both the MV and consumer/equipment compartments and it shall open to the front of the enclosure. It shall not be possible to obtain access to any other compartment from the metering compartment.
- c. The metering compartment shall make provision for the installation of electricity or a maximum demand meter. The electricity meter shall be installed by the contractor.
- d. Two metering test blocks and associated fuse holders (with 2 A fuses fitted, item 1,) shall be fitted in the metering compartment.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- e. The metering unit shall incorporate the following equipment:
 - 1 x 11 000/110 Volt voltage transformer class B 200 VA, 2 x 100/50/5 Amp class 0,5 (As specified in Section RMU 2.18); 15 V A current transformers 1 x 5 amp; 3 phase; 110 V 3 Wire; kWh and kW maximum demand indicating meter with synchronous integral 30 minimum timing device. Scale length to be not less than 300 mm.
- f. The above equipment shall be mounted in a cubicle suitable for mounting on the ring main unit, so as to form an integral part of the switch unit.
- g. It shall be possible to gain access to the VT and CT by means of a door on the side of the enclosure.

ERMU 2.21 Cable Testing Facility

- a. Cable test facilities that are independent of the cable end boxes and are accessible from the front of the RMU are preferred.
- b. For operator safety, the cable testing procedures shall be displayed on the front and inside of the cable testing facility covers.
- c. Cable test facilities shall only be accessible when the isolator / switch are earthed.
- d. A substantial interlock must be fitted to prevent operation of the switch directly from the ON position to the EARTH AND TEST positions. Provision to be made for padlocking in any position.
- e. Cable test terminals to be provided and these to be accessible only when the switch is in the EARTH AND TEST position. Interlocks are to be provided to ensure that the switch cannot be moved from the EARTH AND TEST position when the test terminal access cover is open.
- f. The test terminals to be suitable for cable testing voltages up to 30 kV D C for 15 minutes

ERMU 3 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

ERMU 3.1 Supply and Delivery to Site

<u>Pay Item</u>	<u>Unit</u>
(a) <i>Supply and delivery to site of RMU complete with concrete plinth.</i>	<i>Each</i>

ERMU 3.2 Installation

<u>Pay Item</u>	<u>Unit</u>
(a) <i>Site installation of RMU complete with concrete plinth and floor screed.</i>	<i>Each</i>

ERMU 3.3 Commissioning

<u>Pay Item</u>	<u>Unit</u>
(a) <i>Commissioning of RMU.</i>	<i>Each</i>

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT
WORKS – MECHANICAL AND ELECTRICAL WORKS**

EPPT: POWER TRANSFORMERS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EPPT 1 POWER TRANSFORMERS

EPPT 2 SCOPE

This specification includes the manufacturing, delivery, transport, handling, protection, storage, installation, successful commissioning and upholding during the Defects Liability Period.

The applicable scope of the works covered by this section shall be defined in the Variations and Additions to the Standard and Particular Specifications Section C3.4.2 and relevant Tender drawings.

EPPT 3 CONDITIONS TO SERVICE

The power transformers will be installed indoors or outdoors as specified in the Variations and Additions to the Standard and Particular Specifications on an industrial plant.

EPPT 4 STANDARDS AND TESTS

The power transformers shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply:

SANS 10142	- Code of Practice for the wiring of Premises
NRS 005	- Distribution Transformers
NRS 006	- Switchgear metal enclosed
NRS 008	- Enclosure for cable terminations in air
NRS 030	- Distribution Transformers
SANS 555	- Transformer oil
SANS 780	- Distribution Transformers
SANS 1433-1	- Terminal blocks having screw and screwless terminals
SANS 1433-2	- Flat push-on connectors
SANS 1091	- National colour standards for paint
SANS 1186	- Symbolic safety signs
SANS 1371	- Bushings

EPPT 5 STANDARDS AND DRAWINGS

All materials used shall satisfy the relevant SANS specification and may only deviate from it upon a definite instruction in this specification. The successful Tenderer shall ensure that he possesses the latest edition of the relevant SANS specifications as listed in this specification.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EPPT 6 INDOOR TYPE

The transformers shall be of the free breathing indoor, category 1, DYN 11, low loss type with copper windings and bushings suitable for indoor use, all in accordance with SANS 780. Transformers shall be supplied with all the necessary oil. Transformer oil shall comply with SANS 555. The transformer no load voltage shall be specified in the Variations and Additions to the Standard and Particular Specifications. A five position tap changer shall be supplied to ensure the designed secondary voltage at plus/minus 5 % of the primary voltage in steps of 2,5%.

The transformers shall be matched for parallel operation with percentage voltage impedance tolerance between parallel operated transformers not exceeding 2,5% of rated voltage impedances, same inherent phase angle difference between primary and secondary terminals, same voltage ratio, same polarity and same phase sequence.

Apart from the compulsory accessories listed in table 1 of SANS 780. The transformer shall be equipped with an Oil-level gauge, oil drain plug, bolted tank cover, two shafts and four rollers. A dial type instantaneous and maximum registering indicating thermometer, Bucholz relay (if specified in the Variations and Additions to the Standard and Particular Specifications), trip and alarm contacts on the thermometers and Bucholz relay. The alarm and trip contacts shall be wired to a separate transformer side mounted termination box equipped with rail mounted termination blocks and 3CR12 unpainted removable cable gland plate.

The transformer shall be supplied with a cable end box for termination of medium voltage cables by means of heat shrinkable terminations complete with wooden cable clamps and secondary cables by means of cable glands. Cable terminations shall be suitable to accommodate the cable or cables for each circuit as specified. This applies not only to the number of cores, size and conductor material, but also to the type and construction of the cables. Gland plates in the secondary cable end boxes shall be manufactured from unpainted 3CR12 steel with thickness to suit the cable sizes.

Cable end boxes and terminations shall be complete with the necessary clamps, glands, extension busbars if necessary and other accessories.

Before ordering the Contractor shall ensure that substation doors and transformer platforms are suitably sized for the transformers.

Before commissioning the transformer, the contractor shall ensure that the transformer is properly filled with oil. All the connection terminals shall be taped with insulation tape corresponding with the respective phase colours.

EPPT 7 OUTDOOR TYPE

The outdoor type transformers to be supplied and installed under this Contract shall have a normal no-load voltage ratio as specified with "off-load" tap changer with $\pm 2,5\%$ and 5% taps. The transformer no load voltage shall be specified in the Variations and Additions to the Standard and Particular Specifications.

The transformers shall be matched for parallel operation with percentage voltage impedance tolerance between parallel operated transformers not exceeding 2,5% of rated voltage impedances, same inherent phase angle difference between primary and secondary terminals, same voltage ratio, same polarity and same phase sequence. Gland plates in the secondary cable end boxes shall be manufactured from unpainted 3CR12 steel with thickness to suit the cable sizes

The transformer shall comply with the requirements of SANS 780 as amended to date for low loss transformers with copper windings and bushings suitable for indoor use and shall be of the free breathing outdoor type (or as specified in the Variations and Additions to the Standard and Particular Specifications) fitted with weatherproof MV and LV cable end boxes for termination of

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

medium voltage cables by means of heat shrinkable terminations complete with wooden clamps and secondary cables by means of cable glands secured to a 3CR12 unpainted gland plate.

The transformer shall be supplied completely filled with oil to SANS 555.

In addition to the standard fittings to be provided in accordance with Table I of SANS Specification No. 780, the transformer shall be provided with a detail type instantaneous indicating and maximum registering thermometer, Bucholz Relays (if required), Trip and alarm contacts on the thermometers and Bucholz relay. The alarm and trip contacts shall be wired to a separate transformer side mounted weatherproof termination box equipped with rail mounted termination blocks and removable 3CR12 unpainted cable gland plate.

The transformer shall be provided complete with two axles and four rollers to facilitate rolling of the transformer in the longitudinal direction,

Before ordering the Contractor shall ensure that transformer platforms are suitably sized for the transformers.

Before commissioning the transformer, the contractor shall ensure that the transformer is properly filled with oil. All the connection terminals shall be taped with insulation tape corresponding with the respective phase colours.

EPPT 8 INFORMATION TO BE SUBMITTED WITH TENDERS

Three copies of each of the following drawings shall accompany each tender in respect of the transformers offered:

Outline drawings of the transformer complete with all its accessories, showing main overall dimensions; and

Drawings of the HT and LT bushings.

EPPT 9 INSTALLATION OF POWER TRANSFORMERS

The power transformers shall be installed in the indoor switch room in the positions indicated on the drawings in such a way that the LT bushings of the two adjacent transformers are facing each other.

Outdoor transformers shall be installed in a similar manner and as indicated on the drawings and can be either plinth or pole mounted.

The high-tension terminals on each transformer must be connected to the corresponding medium voltage circuit breaker by means of medium voltage cable via the cable ducts in the floor. At the transformer the cable must be terminated by means of the specified cable end boxes.

The neutral terminal on the LV side of each transformer as well as its earth terminal shall be connected to the substation earth as specified elsewhere in this document.

The connections between the low voltage terminals and the relevant board shall be done by means of the specified cable. The cable shall be terminated at the transformer by means of a heat shrinkable dry type crimped end kit.

After testing, the terminals must be insulated with busbar putty and taped with coloured PVC tape.

The necessary concrete plinths for the transformers will be provided by others under this contract.

On completion of the installation, but prior to commissioning the contractor shall do the following:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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- (a) Ensure that all stoppers have been removed from the breather pipe and oil conservator connection pipes on each transformer;
- (b) Check the oil level of each transformer and top up if necessary;
- (c) Check the tap positions on the transformer tap changers and ensure that both are in the same positions;
- (d) Check the elements of the dehydrating breathers on the transformers in order to ensure that these are dry. Replace if necessary; and
- (e) Check each transformer and dehydrating breather assembly for oil leaks and rectify if necessary.
- (f) Remove all packings from relays and instruments.

EPPT 10 TESTING AND COMMISSIONING OF POWER TRANSFORMERS

On commissioning of the power transformers, the following shall be done;

- (a) The contractor shall verify phase denomination on both HV and LV sides prior to terminating the cables.
- (b) After energising the contractor shall proof phase rotation on the LV side of all transformers.
- (c) After all testing had been carried out satisfactorily the transformer terminals and the terminals on the end boxes must be insulated with busbar putty and taped with coloured PVC tape. All arcing horns (if any) must be removed.
- (d) All transformers shall be properly and permanently labeled in accordance with the feeder switchgear labeling system.

EPPT 11 EARTHING

All transformers shall be earthed to the common medium voltage earthing system by means of 70mm² bare copper conductors.

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 0142.

EPPT 11.1 Design and Approval

The Contractor shall allow for soil resistivity tests to be performed on site. A detailed report on the resistivity tests shall be submitted to the Engineer together with a preliminary earthing scheme showing how the Contractor envisages installing the earth mat before commencing installation of the earth mat. The Contractor shall employ a specialist to investigate, plan and install the earthing installation.

The earth mat installation shall incorporate earthing electrodes at the extreme corners of the station, in the vicinity of earthing switches and transformer neutrals. The substation fences shall also be earthed at regular intervals including all substation gates. The installed maximum earth resistance shall be 1 Ω , or as agreed by the Engineer. The earth conductors shall generally be laid at a depth of more than 500 mm below the finished surface.

The complete earth mat design shall be submitted for written approval. The Engineer may then add or delete equipment and change the design of the earth system if he so requires. The installation of the earth mat shall be so arranged as not to cause delays in civil works.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EPPT 11.2 Earth Resistance Survey

If specified in the Variations and Additions to the Standard and Particular Specifications. The Contractor will be responsible to have an earth resistance survey carried out on site by a specialist in this field, to be approved by the Engineer. The test shall be done on the undisturbed site, i.e. before earth works, trenching, building etc. commence.

The Engineer shall attend the survey. The Contractor shall inform the Engineer in good time when the test is scheduled to take place. If it is done without his or his representative being present, the test shall be repeated in the Engineer’s presence at no additional cost.

The results of this survey will be used to adjust the earthing system as specified herein, if necessary, on the basis of the quoted rates.

Payment for the services of the specialist shall be by the Contractor.

EPPT 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EPPT 12.1 Supply and Delivery to Site

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of power transformers	Each
(b) Supply and delivery to site of substation earthing system	
Sum	

ERMU 2 Installation

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of power transformers	Each
(b) Installation of substation earthing system	Sum

ERMU 3 Commissioning

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of power transformers	Each
(b) Commissioning of substation earthing system	Sum

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

EMSS MINIATURE SUB STATIONS

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EMSS MINIATURE SUB STATIONS

EMSS 1 SCOPE OF WORKS

As specified in the Project Specifications.

EMSS 2 STANDARDS

The miniature substation shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply:

Table 3: Applicable Standards

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
SANS 10142-2	Code of Practice for the wiring of Premises (Medium voltage)
NRS 030	Distribution Transformers
NRS 004	Miniature substations
NRS 005	Distribution Transformers
NRS 006	Switchgear metal enclosed
NRS 008	Enclosure for cable terminations in air
SANS 152	Low voltage air break switches
SANS 156	Low voltage moulded case circuit breakers
SANS 172	Cartridge type fuse-links for low voltage electric fuses
SANS 064	Preparation of steel surfaces for coating
SANS 555	Transformer oil
SANS 780	Distribution Transformers
SANS 1029	Miniature substation
SANS 1091	National colour standards for paint
SANS 1186	Symbolic safety signs
SANS 1195	Bus bars
SANS 1371	Bushings
SANS 62271-202	Prefabricated Substation
NRS 012	Cable box's
SANS 62271-200	Switchgear general spec
SANS/IEC 60076	Transformer
ERMU	Bigen Africa Ring Main Unit Particular Specifications

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMSS 3 STANDARDS AND DRAWINGS

All materials used shall satisfy the relevant SANS specification and may only deviate from it upon a definite instruction in this specification. The successful Tenderer shall ensure that he possesses the latest edition of the relevant SANS specifications as listed in this specification.

EMSS 4 GENERAL REQUIREMENTS

The miniature substation shall consist of three / four separate compartments as specified in the Project Specifications, bolted together with common interlocked access doors to the Medium Voltage, Area Lighting, Transformer and Low Voltage compartments.

These doors shall be provided with latches for padlocks.

The transformer shall have a normal no-load voltage as specified in the Project Specifications. The miniature substation shall all be in accordance with the details of this specification and generally in accordance with SANS 1029 and NRS 004-1 complete with switchgear and other auxiliary equipment.

The miniature substation shall be completely tamper proof with tamperproof pad lock covers and supplied ready for mounting on a concrete plinth.

All units must comply with the Occupational Health and Safety Act, (Act 85 of 1993).

The units offered must provide Internal Arc Venting as per SANS 1029.

EMSS 5 PRE-MANUFACTURER

EMSS 5.1 Structural Drawings, with critical dimensions

- Arrangement;
- Plan, front view, and elevation section views;
- Required clearances for opening doors and for removing breakers;
- Conduit or cable trays entrance locations and dimensions for both top and bottom entrance;
- Bus bar locations and configurations;
- Incoming and outgoing power cable terminator positions;
- Anchor bolt locations;
- Grounding connections;
- Weight of equipment;
- Elementary Three-Line Diagrams.

EMSS 5.2 Three-line diagrams, with function numbers used throughout

- Instrument transformers;

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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- Relays;
- Meters and meter switches;
- Breakers and other pertinent devices;
- Schematic Diagrams;
- Schematic diagrams shall be furnished for the electrically-operated breaker / relay control scheme;
- Each schematic diagram shall show device and terminal block terminal numbers for customer connections;
- Provide control switch development tables.

EMSS 5.3 Detailed Connection (Wiring) Diagrams

- Approximate physical location of all items in each unit;
- All wiring within each unit;
- All interconnecting wiring between units;
- Identification of all terminals, terminal blocks, and wires;
- Provide one set of drawings shipped with the switchgear for start-up use.

EMSS 5.4 Material List

- An electrical bill of material list shall be furnished listing the quantity, rating, type, and manufacturer's catalogue number of all equipment on each unit.

EMSS 5.5 Installation, Operating, and Maintenance Instructions

- Installation, operating, and maintenance instructions shall cover switchgear, breakers, relays, meters and devices requiring installation, programming and / or maintenance;
- The breaker operating mechanism shall be front-accessible, and all routine maintenance shall be performed with the breaker in an upright position.

Notes:

- a) These drawings shall be submitted for approval before the manufacturing of the miniature sub for this particular service.
- b) The approval of drawings shall not relieve the Contractor of his responsibility to the Client to supply the miniature sub according to the requirements of the specification.
- c) The miniature sub must be inspected at the manufacturer's premises before dispatch on completion.

EMSS 6 CONSTRUCTION

The general arrangement of the Miniature Substation shall be in accordance with the Type B (lateral) layout, specified in SANS 1029.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The Miniature Substation enclosure shall be designed to comply with the internal arc testing requirements of SANS 1029, design details shall be submitted to the Engineer for approval.

A barrier shall separate the end of the Low Voltage compartment (located on the Low Voltage side of the transformer) from the front Low Voltage compartment.

The Miniature Substation earth busbar shall be accessible from the front of the ring main unit. The ring main unit shall be bonded to the miniature substation earth busbar by a 70 mm² copper conductor.

All unscreened connections used for the interconnections between the ring main unit and the transformer Medium Voltage bushings shall be barricaded (protected) to prevent inadvertent contact by persons requiring access to the Medium Voltage compartment.

Provision shall be made for the support (clamping) of two incoming (ring) cables in the Medium Voltage compartment. Two adjustable cable clamps, suitable for clamping one 240 mm² x 3 core copper shall be provided with the Miniature Substation. The minimum distance from the cable support point (clamp) to the ring main unit bushing centres shall be 650mm as per NRS 012.

EMSS 6.1 General Construction

The Miniature Substation shall be suitable for outdoor use which will be stipulated in Project Specifications, and shall be divided into three or four compartments:

- a) Medium Voltage compartment;
- b) Transformer compartment;
- c) Low Voltage compartment;
- d) Area Lighting.

The Miniature Substation enclosure (roof, compartments and doors) and transformer tank shall be suitable for non-corrosive environments.

For non-corrosive environments, the unit shall be 3mm mild steel or as specified in the Project Specification.

EMSS 6.2 Doors and Enclosures

The entire lock and door closing enclosure mechanism must be enclosed by means of a metal cover box. The metal box must be open on the bottom so as to enable the lock to be put in place.

The doors shall be fitted to all compartments and shall be constructed of steel as specified in the Project Specifications, minimum thickness of 3mm and shall be watertight and vermin proof.

The doors shall close against a drip proof door frame forming part of the relevant compartment.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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All uni-strut channels, nuts, bolts and washers shall be stainless steel type.

EMSS 6.3 Hinges

Hinges shall be manufactured from stainless steel. Hinged doors shall exert uniform pressure at all points on the gasket when the door is closed to ensure proper closing and to prevent the penetration of water and vermin.

EMSS 6.4 Handles and Locks

All access doors shall be fitted with locking facilities for padlock type locks complete with tamper proof lock covers.

Handles shall be of the lockable 3 point steel lever type with locking catches and padlock facilities.

The Contractor shall supply padlocks to the client’s specification, which shall be confirmed on site.

EMSS 6.5 Base Construction

The housing shall be erected on a U-section steel frame hot dipped galvanised in accordance with SANS 763 with measurements of not less than 75 x 50 x 5mm. It shall be rigid, robust and completely self-supporting.

EMSS 6.6 Signage

Danger signs on External Chromadek plates shall be supplied on each door and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

Doors must be indelible marked MV/S and LV/S as applicable on the insides.

A sign depicting “Treatment and Full First Aid Instructions” shall be permanently attached to the inside of the Medium Voltage and Low Voltage compartment of the door that opens first.

External Chromadek electrical symbolic warning signs (warning-flash) with the words “No Unauthorized Entry Allowed” (in English, Afrikaans and Zulu) shall be permanently attached to all the doors, welded hinge which forms part of the door.

The barrier used to barricade the LV bushings of the transformer shall have a sticker applied to it depicting an electrical symbolic warning sign (warning against “Unauthorized entry”).

EMSS 6.7 Labels

Phase labels shall be provided below all the bushings (primary and secondary) of the transformer and Ring Main Unit.

The Low Voltage busbars shall be color-coded in the colors of red, yellow, blue and black by a clearly visible painted-on spot at least 20 mm diameter.

The Medium Voltage and Low Voltage compartment doors shall be labelled with “MV” and “LV”, respectively. The labels shall be clearly and indelibly stencilled on both the inside and outside of all the compartment doors.

The Low Voltage streetlight compartment door shall be labelled with “STREETLIGHT or AREA LIGHTING COMPARTMENT”, which will specified in the Project Specification. The labels shall be clearly and indelibly stencilled on outside of the streetlight compartment door.

The primary voltage, secondary voltage, ‘kVA’ rating and vector group shall be marked on the miniature substation, example “11kV/420V 500 kVA Dyn11”. The markings shall be black and in characters larger than 50 mm high.

Miniature Substation roof and body shall be marked with stencilled marks that uniquely link the roof to the body.

EMSS 6.8 Paint and Colour

The metal shall be degreased and sand blasted to remove all dust and stains. It shall be painted with one coat of zinc chromate primer and two coats of scratchproof enamel of the colour "Avocado green" No. 12 in accordance with standard specification SANS 1091 on the outside and white on the inside.

The miniature substation steel base shall be hot dip galvanized in accordance with the relevant requirements of SANS ISO 1461 and, in addition, shall be coated with black epoxy tar paint.

EMSS 7 MEDIUM VOLTAGE COMPARTMENT

The Medium Voltage compartment of the miniature substation shall be equipped with an outdoor type non extensible ring main unit comprising of one isolator unit, busbars and one SF6 gas circuit breaker transformer feeder. The ring main unit shall comply with Bigen Africa Ring Main Unit Particular Specification.

The Voltage Detection System (VDS) shall comply with IEC 61243-5. Voltage Presence Indicating Systems (VPIS) shall comply with IEC 61958.

EMSS 7.1 General

The ring main unit (RMU) shall comply with the requirements of SABS 1874. Proof of compliance with the requirements to assess the effects of arcing due to an internal fault in accordance with Sub-clause 6.108 of IEC 60298 is required.

Medium Voltage compartment housing a metal-enclosed ring main unit will comply with the SABS 1874.

The RMU SF6 indicator(s) shall be clearly visible from the front of the mini-substation.

Where Type C bushings are offered, unscreened separable connectors (USC) shall be provided (4.8.4.4 (a) of SANS 1029).

The Voltage Detection System (VDS) shall comply with IEC 61243-5. Voltage Presence Indicating Systems (VPIS) shall comply with IEC 61958.

The Ring Main Unit configuration shall be two (2) x Isolators and One (1) x Breaker tee-off switch to the transformer with Protection.

The Medium Voltage compartment shall be ARC Proof metal enclosed with Top Vent chimney.

Busbar Insulation shall be used on all Medium Voltage Voltage Busbars.

3CR12 unpainted cable gland plates Shall be used in the Ring Main Unit.

EMSS 7.2 Incomer and Feeder Isolator

One (1) Metering Compartment Isolator and one Isolator as specified under Project Specification shall be supplied, strictly accordance to Bigen Africa Ring Main Unit Particular Specification.

EMSS 7.3 Transformer Feeder Circuit Breaker

The transformer feeder circuit breaker shall be equipped with a self-powered over current and earth fault relay complete with class X protection CT's and core balance CT. The switchgear shall be suitable for operation on a voltage system as specified in the Project Specifications, if not specified the fault capacity of 250MVA shall be used for calculations.

The over current earth fault protection settings shall be suitable for the transformer rating as specified Project Specifications and Bigen Africa Ring Main Unit Specification.

The circuit breaker shall be of the maintenance-free, low pressure SF6 gas type. The position of the power and earthing contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 60265-1 standard. In addition, manufacturer shall prove reliability of indication in accordance with IEC 60129 standard. The circuit breaker shall have 3 positions: open-disconnected, closed and earthed and shall be constructed in such a way that natural interlocks prevent all unauthorized operations. They shall be fully mounted and inspected in the factory.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button. There will be no automatic reclosing.

The circuit breaker shall be associated with an integrated protection unit that will operate without any auxiliary power supply and shall include:

EMSS 7.4 Electronic Protection Relay

The electronic protection relay shall be designed for use in distribution networks, mainly in MV/LV substations in which it shall provide protection upstream from the transformer.

The relay shall be self-powered and shall not require any auxiliary supply and shall be supplied by the current sensors.

The protection relay provides protection against phase-to-phase faults and earth faults.

Protection against earth faults shall operate by measurement of residual current based on the sum of the sensor secondary currents. Measurement shall be carried out by a core balance CT mounted on the back of the relay unit. Earth protection operates with definite time. The setting and time delay shall be adjustable.

The electronic protection relay shall be supplied complete with sensors to obtain the specified setting performances.

In the event of a short-circuit the cross-section of the core and the resistance of the winding shall be adapted to protect the protection relay.

The Relay will have the following capabilities:

- Buchholz Alarm indication;
- Buchholz Trip and Indication;
- Temperature Alarm indication;
- Temperature Trip and Indication;
- Transformer protection with Differential Protection Relay o/c and e/f plus o/c high sets relay equivalent to existing protection relays with settings between 15% and 200% for o/c and between 20% and 80% for e/f elements.

EMSS 7.5 Cable Testing and Earthing Facilities

Cable testing and earthing facilities are required. Interlocks shall be provided to prevent access to the test terminals or orifices until the circuit is earthed.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

In event of a separate test unit being required, it shall be easily fitted without having to remove the canopy of the miniature substation and this unit shall also be provided and stored in a suitable receptacle in the HV compartment.

EMSS 7.6 Medium Voltage Unistrut

A suitable Unistrut for securing the Medium Voltage cables by means of "K"-clamps or wooden cleats shall be installed in the Medium Voltage compartment.

EMSS 7.7 Earthing

The earth of the fuse switch shall be connected to the miniature substation's earth with a flat copper earth bar with three (3) 12mm holes in the Medium Voltage compartment.

The under frame, neutral and transformer tank of the miniature substation shall be connected to the earth busbars with 70mm² copper conductors or equivalent earth copper bar.

The Medium Voltage and Low Voltage earth busbar shall be interconnected by means of a 70mm² copper conductor or equivalent earth copper bar.

The earth bar (referred to as Medium Voltage earth busbar), construction and earthing is to be performed in accordance with clause 4.7.4, SANS 1029.

EMSS 7.8 Cable End Boxes

Large size cable end boxes shall be provided on the Medium Voltage switchgear suitable for heat shrink terminations.

Cable boxes shall be complete with the necessary clamps, tapes, glands, terminating and other accessories.

Provision must be made for heat shrink type terminations in the end boxes.

EMSS 8 TRANSFORMER COMPARTMENT

The transformer compartment of the miniature substation shall be equipped with a transformer.

EMSS 8.1 General

The transformer shall be of the double wound, three phase, oil immersed, self-cooled type with copper windings and shall comply with SANS 780 where applicable. The transformer shall be of the low loss sealed type.

The rated impulse voltage withstand level (BIL) and the rated short-duration power frequency withstand r.m.s. voltage (1 min) of the transformer shall test at the factory acceptance test, please see example below of the minimum tests:

Rated voltage kV (r.m.s.)	Rated lightning impulse withstand voltage (BIL) kV (peak)	Rated short-duration power frequency withstand r.m.s. voltage kV (r.m.s.) – 1 min
11	95	28
0,420	30	1

EMSS 8.2 Rating

The transformer shall be rated as specified in the Project Specifications. The maximum temperature rise shall not exceed the limits as laid down in SANS 780.

EMSS 8.3 Internal Connections

The high voltage winding shall be connected in delta, and the low voltage winding in star, with the neutral brought out (Dyn 11).

The vector group of the transformer shall be Dyn11, refer SANS 1029.

The transformer Medium Voltage bushing required is the Type C bushing as specified in SANS 1029.

The transformer earth terminal shall be a 30 mm long boss, with an M12 thread throughout, welded to the transformer tank. The boss shall be fitted with a M12 × 25 mm self-locking setscrew. The boss and the setscrew shall be stainless steel of grades 304 and 316 respectively.

EMSS 8.4 External Connections

The connections on the Medium Voltage and Low Voltage side shall all be of the same size.

All Medium Voltage connections shall be properly insulated. An externally operated off-load tap changing switch shall be provided enabling the secondary voltage to be varied from 95% to 105% in five steps.

Open Low Voltage bushings shall be protected by means of a Perspex cover to prevent accidental contact with live equipment.

EMSS 8.5 Accessories

The transformer shall be equipped with the following accessories:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



- Drain valve;
- Oil gauge;
- Lifting hooks;
- Earthing terminal.

EMSS 8.6 Tests

Certified copies of test certificates shall be forwarded to the Engineer as soon as possible after the tests have been carried out. Testing of the transformer shall be in accordance with SANS 780.

EMSS 9 LV COMPARTMENT

EMSS 9.1 Low Voltage Busbars

The following additional requirements for LV panel are required:

- The spacing between the lowest Low Voltage phase busbar and the Low Voltage neutral-earth busbar shall be 300 mm.
- The spacing between the Low Voltage neutral-earth busbar and the uni-strut channel shall be 200 mm.
- The Low Voltage busbars shall be rated as indicated in SANS 1029 and the current density shall not exceed 1.8 A/mm².
- Busbar Insulation shall be used on all Low Voltage Busbars.

EMSS 9.2 Low Voltage Unistrut

Uni-strut channel shall be provided for the outgoing Low Voltage feeder cables shall be at least 3 mm thick and shall be mounted on a steel support structure that is insulated from the Miniature Substation enclosure. The cross-sectional area of the individual steel support structures shall be at least 70 mm² which must be earthed in accordance SANS 1029.

EMSS 9.3 Area Lighting

A compartment for exclusive use of the street lighting or area lighting control panel shall be located in the in the Low Voltage end compartment of the Miniature Substation as shown SANS 1029 with its own door. The equipment shall be specified in the Project Specifications.

EMSS 9.4 Equipment

The Low Voltage compartment shall be equipped with the following:

- a) A single front panel mounted 400 Volt voltmeter with HRC fuses and 4-position selector switch to measure phase voltages.
- b) Three combined instantaneous and maximum demand ammeters, one for each phase and

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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appropriately labelled.

These ammeters will be wired to indicate the total LV current of the transformer.

- a) The LV compartment is to be provided with tinned copper busbars complying with BS159 and of suitable dimensions to carry the full load current of the transformer at a current density of not more than 1.8 A/mm². The neutral bar shall have the same dimensions as the phase bars. An earth bar with dimensions of ±31,5 x 6,3mm shall be supplied along the full width of the LV compartment. The busbars shall be phase colour coded.

Connections to bus bars shall be effected by means of cable lugs and suitably sized cadmium-plated, high tensile steel bolts and nuts with cadmium-plated cup washers or lock washers. Spare connections shall be provided complete with bolts, nuts, washers and spring washers.

- a) Install in the low voltage compartment a suitably rated three pole circuit breaker as specified in the Project Specification.
- b) Feeder circuit breakers shall be supplied as specified in the Project Specifications. A removable cover shall be installed in front of the cable terminations on the feeder circuit breakers to prevent accidental contact with live conductors.
- c) **3CR12 unpainted cable gland plates** with suitable gland openings shall be provided at the bottom of the compartment for feeder cable terminations. The gland plates shall be secured to a DIN rail, supplied along the full width of the Low Voltage compartment, to allow positioning of the gland plates in any required position.

Note:

Circuit breakers, isolators, meters and maximum demand ammeters shall be flush mounted behind a sheet steel panel. In all other respects the panel shall comply with the requirements as specified for distribution board panels.

EMSS 9.5 Protection

A safety shield manufactured of either Perspex or Tuffnol shall be fitted to cover the bushings in the Low Voltage compartment.

EMSS 10 CONCRETE BASE FOR MINIATURE SUBSTATION

The miniature substation shall be mounted on a concrete plinth. The concrete of the plinth shall be of cement, sand and stone, in the ratio of 1:2:4.

The concrete plinth shall reach from at least 300mm below the natural surface at the lowest point to 200mm above the surface at the highest point. The plinth shall also be in accordance with the miniature sub manufacturer's details.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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The onus rests on the Contractor to ensure that the concrete plinth is sufficiently reinforced and adequately braced so that it does not collapse.

The plinth must have an opening under the high- and low voltage compartments, so that all cables can easily be pulled in. The inside of the plinth must also be plastered.

EMSS 11 INSTALLATION OF MINIATURE SUBSTATIONS

Miniature substations shall be installed on concrete foundations, and secured to the foundation by means of Grade 304 Stainless Steel holding down bolts cast into the concrete. The foundation shall extend from 300 mm below the final ground level at the lowest point to 200mm above the highest point. The foundation shall be between 250 and 300mm wide and the area beneath the high tension, low tension and transformer compartment shall be left open to facilitate the installation of all the cables. It shall have neatly bevelled edges and shall be 75 mm wider than the miniature substation all round.

Cable entries underneath the foundations shall be well compacted after filling to prevent subsequent subsidence.

After the placing of substations the contractor shall undertake the necessary excavations in such a way that the soil underneath the foundation of the miniature substation will not give way.

The contractor shall then haul the cables in and terminate the cable ends onto the switchgear taking due cognisance of the phase rotation.

The low-voltage feeder cables shall be terminated by means of copper cable glands and lugs, which have been approved by the Engineer.

The contractor shall mount additional circuit breakers when required.

Where cables are terminated onto circuit breakers by means of short busbars the cable lugs shall be covered with shrouds in order to cover live open portions where the gap between phases and from phase to earth is less than 40 mm.

After the trenches around and underneath the miniature substation has been backfilled and compacted properly the contractor shall fill the inside volume of the concrete plinth and cast a 50mm cement screed on top of the filling soil 100mm underneath the base channel of the miniature substation. A sand/cement mixture of 5:1 shall be used.

The miniature substation shall be cleaned and tidied inside and shall be free from dust, oil or any foreign matter and shall be maintained until handing over.

The contractor shall be responsible to keep the miniature substation locked to prevent equipment from being stolen from it. The contractor shall provide his own padlocks for this purpose.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMSS 12 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 0142.

The substation and Medium Voltage Miniature Substation room earthing shall consist of a 70mm² bare copper earth wire installed in the same trench as the Medium Voltage supply cables.

Earth resistivity measurements of less than 1 ohm will be acceptable

EMSS 13 TECHNICAL INFORMATION

Test certificates, technical details and brochures shall be submitted to the Engineer for approval before manufacture.

Suppliers who cannot produce satisfactory test evidence that their equipment has passed short-circuit tests at the specified fault levels, must include in their tender for those tests to be carried out at the SABS testing laboratories. These tests shall be witnessed by the Engineer.

EMSS 14 PROTECTION SETTINGS

The Contractor will be responsible to have protection setting calculation done by a specialist in this field, to be approved by the Engineer. The protection settings shall allow discrimination between protection settings of supply authority switchgear, plant incomer and distribution system medium voltage switchgear protection settings and protection settings shall be done by the specialist and demonstrated for correct operation by means of secondary injection test procedures.

The Engineer shall attend the test demonstration and the Contractor shall inform the Engineer in good time when the test is scheduled to take place. If it is done without him or his representative being present, the test shall be repeated in the Engineer's presence at no additional cost.

Short circuit analysis and coordination study "Short Circuit Analysis/Coordination Study" shall be completed and submitted with switchboard submittal to confirm interrupting rating of submitted equipment is adequate for the point of application in the electrical distribution.

Payment for the services of the specialist shall be by the Contractor.

EMSS 15 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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EMSS 15.1 Design, Drawings and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. Miniature substation installation, design information shall include, but limited to, the following:

- Manufacturer's product data of miniature substation and all related components.
- Dimensioned drawings of miniature substation showing accurately scaled basic units including, but not necessarily limited to, auxiliary compartments, unit components and combination units.
- Schematics and wiring diagrams for metering and controls.
- Furnish, upon request, manufacturer's certification of rating of the basic breaker, switch and fusing components and the integrated metal-enclosed interrupter switchgear assembly.
- Short circuit analysis and coordination study "Short Circuit Analysis/Coordination Study" shall be completed and submitted with switchboard submittal to confirm interrupting rating of submitted equipment is adequate for the point of application in the electrical distribution.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide design drawings and design information for medium voltage switchgear	Sum
(b) Allowance for short circuit analysis and coordination study and protection setting calculations	Sum

EMSS 15.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For miniature substation, the rate tendered shall be for the complete miniature substation and shall include, but not limited to, the detailed in this particular specification. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2 .

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of miniature substation complete with concrete plinth	Each

EMSS 15.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

<div></div> <div>Contractor</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>	<div></div> <div>Employer</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>
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Install of miniature substation shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the miniature substation complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of miniature substation but not limited to.

<u>Pay Item</u>	Unit
(a) Site installation of miniature substation complete with concrete plinth and floor screed	Each
(b) Earthing resistance survey	Sum
(c) Protection setting calculations and setting of protection relays	Sum

EMSS 15.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, testing apparatus, instruments and equipment, any/all equipment required for testing purposes and to prove performance, any/all temporary works, and compilation of final commissioning report.

Prior to energization, check miniature substation for continuity of circuits and for short circuits. Each miniature substation line up bus shall have its insulation resistance tested after the installation is complete except for line and load side connections. Tests shall be made using a Megger Earth Tester or equivalent test instrument at a voltage of not less than 1000 volts dc. Resistance shall be measured from phase to-phase and from phase to-ground.

Following completion of the construction work and prior to final acceptance testing, the overcurrent ground fault protection systems shall be field-tested with a test-set checking the calibration of each relay and reset to the manufacturer's settings for both current and time. Contractor shall furnish a time current coordination study. Submit the results on log-log paper showing coordination with downstream devices. Contractor shall submit three copies to the Engineer. Contractor shall notify the Engineer one week in advance of the test so that the Engineer may be present. Coordinate final overcurrent and time setting with the supply authority switchgear, plant incomer and distribution system.

<u>Pay Item</u>	Unit
(c) Commissioning of miniature substation	Each

END OF SECTION

<div></div> <div>Contractor</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>	<div></div> <div>Employer</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>
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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

EMCC MOTOR CONTROL CENTERS AND DISTRIBUTION BOARDS

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EMCC MOTOR CONTROL CENTERS AND DISTRIBUTION BOARDS

EMCC 1 SCOPE OF WORKS

As specified in the Project Specifications.

EMCC 2 STANDARDS AND TESTS

The motor control centres shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Table 4: Applicable Standards

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
BS 159	Bus bars
SANS 1195	Bus bars
SANS 1091	Paint colour
BS 3938	Current Transformers
SANS 60044	Current Transformers
NRS 029	Current Transformers
BS 89	Ammeters
BS 638	Welding cables
SANS 1576	Welding cables
SANS 156	Moulded Case Circuit Breakers
SANS 767	Earth leakage protection units
SANS 1574	Electric cables and flexible cords
NRS 002	Graphical symbols for electrical power, telecommunications and electronic diagrams
SANS 1213	Mechanical cable glands
SANS 1433-1	Terminal blocks having screw and screw less terminals
SANS 1433-2	Flat push-on connectors
SANS 1473-1	Low-voltage switchgear and control gear assemblies: Type-tested and partially type-tested assemblies
SANS 1473-2	Low-voltage switchgear and control gear assemblies: Busbar trunking systems
SANS 1619	Small power distribution units (ready boards) for single-phase 230V service connections
SANS 1765	Safety of distribution boards
SANS 10292	Earthing of low-voltage distribution systems
SANS 60439-2	Low-voltage switchgear and control gear assemblies: Particular requirements for busbar trunking systems

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Standard No.	Description
SANS 60439-4	Low-voltage switchgear and control gear assemblies: Particular requirements for assemblies for construction sites
SANS 60947-2	Low-voltage switchgear and control gear: Circuit breakers
SANS 60947-3	Low-voltage switchgear and control gear: Switches and disconnectors
SANS 60947-4-1	Low-voltage switchgear and control gear: Contactors and motor starters (Electromechanical)
SANS 60947-4-2	Low-voltage switchgear and control gear: Contactors and motor starters (semiconductor motor controllers)
SANS 60947-4-3	Low-voltage switchgear and control gear: Contactors and motor starters (For non-motor loads)
SANS 60947-5-1	Low-voltage switchgear and control gear: Electromechanical control circuit devices
SANS 60947-5-2	Low-voltage switchgear and control gear: Electrical emergency stop device with mechanical latching function
BS 89	Ammeters
NEMA ICS 18	Industrial Control and Systems: Motor Control Centres
UL 845	UL Standard for Safety for Motor Control Centres
IEEE C37.20.7	Arc-resistant or arc-containing low voltage MCCs shall be tested, rated, and labelled in accordance with the requirements of IEEE C37.20.7 'IEEE Guide for Testing Metal enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults'

EMCC 3 QUALITY ASSURANCE

The manufacturer of the MCC shall have a minimum of **25-years' experience** in the manufacturing and assembly of Low Voltage motor control centres and distribution boards.

Motor control centres and distribution boards shall be designed and manufactured in accordance with all the above mentioned standards.

EMCC 4 PRE – MANUFACTURE SUBMITTALS

EMCC 4.1 Manufacturer Drawings

MCC elevations showing dimensional information including details such as, but not limited to, the following:

1. MCC height (less any removable lifting angles or eyes);
2. MCC width;
3. MCC depth;
4. Location of shipping splits;

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EMCC 4.2 Structure Descriptions Showing the Following

1. Bus ratings;
2. Enclosure ratings;
3. Short-circuit withstand ratings;
4. Cascaded systems;
5. Type 1, type 2 or full coordination system;
6. Other information as required for approval.

EMCC 4.3 Product Data

Data sheets and publications on all major components including, but not limited to, the following:

1. Motor starters
2. Overload relays
3. Circuit breaker and fuse information including time current characteristics
4. Control power transformers
5. Pilot devices
6. Relays
7. Timers

EMCC 4.4 Specifications Response

All clarifications and exceptions to the project specifications must be clearly identified and marked up on the drawing.

EMCC 4.5 Specifications Response

Provide a copy of the manufacturer's installation instructions that includes the following:

1. Receiving, handling, and storage instructions;
2. Nameplate data, serial numbers, UL markings, and short circuit ratings;
3. Installation procedures including splicing procedures, terminations and connections;
4. Conduit and cable installation;
5. Installing and removing plug-in units;
6. Operation of operator handles and unit interlocks;
7. Checklist before energizing;
8. Procedure for energizing equipment;
9. Maintenance procedures.

4.6 Final Submittals

1. The contractor shall provide certification that the all components or MCC has been installed in accordance with the manufacturer's instructions and with local codes and standards that govern MCC installations.
2. The contractor shall provide certification that all circuit breaker settings have been adjusted

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- per field requirements.
3. The contractor shall provide certification that all power fuses have been selected and installed per field requirements.
 4. The contractor shall provide certification that all solid-state motor overload settings have been adjusted per installed motor characteristics.
 5. The contractor shall provide certification that all settings for solid state devices such as reduced voltage solid-state controllers and variable frequency drives have been adjusted per the specific application requirements.
 6. The contractor shall provide certification that any timing devices have been properly adjusted.
 7. Test reports indicating manufacturer's standard testing was performed.
 8. MCC installation instructions
 9. Installation/operation instructions for major components such as, automatic transfer switch and circuit breakers
 10. MCC spare parts listing and pricing
 11. Technical details and descriptive literature regarding all equipment and instruments offered;
 12. Three paper prints of all of the above for final hand-over.

All settings as above detailed shall be indicated on the final drawings.

EMCC 5 DELIVERY, STORAGE AND HANDLING

The contractor shall coordinate with the Engineer manufacturer for entry into the building.

The contractor shall store the MCCs in a clean, dry, and heated space.

The contractor shall protect the units from dirt, water, construction debris, and traffic.

During storage the contractor shall connect internal space heaters (if specified) with temporary power.

EMCC 6 MANUFACTURER

EMCC 6.1 Ratings

The MCC shall be rated for the system voltage as indicated in the Project Specifications.

The MCC horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as indicated in Project Specification.

All MCC units shall have a full rated short-circuit rating that meets or exceeds the available fault current as indicated in the Project Specification.

All circuit breakers used in the motor control centre shall have full-rated short-circuit interrupting ratings based on the applied MCC voltage.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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The manufacturer shall be certified by South African Bureau of Standards or accredited testing facility which is to approval of the Engineer in manufacturing motor control centres or distribution boards to the specified withstand fault current as detailed in the project specification. If the contractor does not have certification to build motor control centres or distribution boards to the rated withstand fault current as specified in the project specifications, it will be to the cost of the contractor to fully type test the assemblies at South African Bureau of Standards at the contractors cost.

The contractor shall have certificate from South African Bureau of Standards which is higher or is equal to the specified withstand fault current.

Motor control centre and distribution board shall be type tested as laid out South African Bureau of Standards to the rated withstand fault current as indicated in the Project Specification.

EMCC 6.2 Enclosure

The motor control centre or distribution board shall be suitable for the environmental conditions in which it operates. The motor control centre and distribution board shall be protected against corrosion.

Any point of a motor control centre or distribution board that has to be reached during normal operation shall not exceed a height of 2,2 m above floor (or walking) level. However, the board may be mounted higher if it can be disconnected from the supply by a switch-disconnector or circuit breaker that is less than 2,2 m above floor level.

The motor control centre board or distribution board shall be of the free standing floor mounted type with a minimum IP rating of 55 (insect proofed enclosure). The motor control centre or distribution board shall be constructed with a minimum of 2mm steel which will rest on a rigid channel iron or similar frame and for outdoor 3CR12 rigid channel shall be used, and shall be bolted down in position by means of M16 high tensile stainless steel bolts grouted into the concrete floor, the bolts shall be inside the board.

The panel door shall be provided with a locking system suitable for padlocking. The locking system shall consist of a 3-way locking mechanism locking the door at the top, middle and bottom. The unit doors shall be capable of being opened at least 110 degrees.

The motor control centre or distribution board shall be provided with removable covers on the sides and hinged panels on the front. All removable covers shall be suitably braced and reinforced to ensure rigidity.

The board shall be provided with readily removable, sectionalized, rigidly supported unpainted 3CR12 cable end support gland plates along the entire length of the board and at least 230 mm above floor level.

This compartment shall if necessary consist of an outer and inner shell with at least 10 mm insulation or polystyrene between the inner and outer shell all round to keep the temperature

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

inside the compartment at least 5 Degree Celsius below the temperature surrounding the compartment in summer complete with ventilation fans.

The board shall be suitably sized to accommodate without cramping, all the switchgear and equipment specified. Motor starter panels shall be a segregated system with each motor starter housed in a separate panel complete with door interlocked main switch. Where motor starter panels are installed on top of each other cable access shall be provided from the side of each panel by means of a common cable marshalling panel. Provision shall be made for pre-wiring between the starter panel and cable connectors inside cable marshalling panel to facilitate site cable connections.

All switch gear, instruments and equipment for the control of any specific motor or other electrical device, shall be mounted flush behind a common hinged panel, with only operating handles, push buttons and instrument faces protruding through neatly machine punched holes in the panel.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer's requirements are met.

Screwed-on engraved labels in English shall be provided below all switchgear and equipment on and in the panels, to facilitate identification.

All unpainted parts shall be plated for corrosion resistance.

The systems shall be designed to allow for **30%** for future extensions.

EMCC 6.2.1 Indoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty rust proof hinges.

Each panel shall be supplied with concealed hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be Cadmium plated. The use of self-tapping screws will not be permissible.

EMCC 6.2.2 Outdoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty stainless steel hinges.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Each panel shall be supplied with concealed stainless steel hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be stainless steel plated. The use of self-tapping screws will not be permissible.

The outdoor motor control boards shall be constructed of at least 2mm powder coated 3CR12 steel. Vermin proofed IP 54 rated ventilation openings shall be provided in doors and side panels. A 3CR12 roof shall be added to all outdoor motor control centres and distribution boards with a minimum slope of 1/10.

EMCC 6.2.3 Busbars

The board shall be provided with one set of four solid, copper busbars in the top section and extending over the entire length of the board. Provision shall be made at the end of each busbar for future extensions. Bus bars shall comply with the requirements of BS 1433, SANS 1973-8 and SANS 1195. A solid copper earth bar shall be provided inside the board above the gland plate along the entire length of the board.

Busbars shall be rigidly supported at suitable intervals to prevent undue damage resulting under short circuit conditions. Ceramic or other approved busbar insulators shall be used. The busbars shall be arranged horizontally with the longer sides of the cross-sections in the vertical plane and one behind the other, in the horizontal plane, at 90mm centres.

Busbars shall be clearly and indelibly marked in the middle of the bus bar Red, White and Blue for the three phases and Black for Neutral.

The earth bars shall be drilled and provided with 6 mm diameter and 10 mm diameter cadmium plated, high tensile steel bolts and nuts, complete with cadmium-plated washers and cup washers or lock washers, for making the earth connections. The earthing positions shall be evenly spaced along the entire length of each busbar.

Connections to busbars shall be effected by means of cable lugs and suitably sized cadmium-plated, high tensile steel bolts and nuts with cadmium-plated cup washers or lock washers. Spare connections shall be provided complete with bolts, nuts, washers and spring washers.

EMCC 6.2.4 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in an outdoor distribution or motor control board, this equipment shall be installed in a separate and special compartment and all wiring shall be terminated on rail mounted terminal strips for field connection of all monitoring and control cables.

The doors of this compartment must be labelled: "Electronic Equipment".

All the electronic equipment but not limited to HMI, power supply, PLC CPU, Ethernet switch, fibre switch, all I/O cards, UPS and telemetry and 30% additional space for the future. All equipment shall be mounted flush behind a common hinged panel, with laminated, shatterproof and tinted glass for viewing purposes.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer's requirements are met.

The tier shall be designed to house all of the above equipment and the manufacturer shall coordinate with communication and instrumentation specialist.

EMCC 6.2.5 Treatment And Painting Of Metal Parts

All metal parts shall be treated before powder coating in accordance with standard corrosion protection standards and the appropriate coating system shall be selected for the specific application. Motor control centre outer surfaces shall be powder coated colour B26, SANS 1091. (Electric orange)

An average of 2 mil thick electrostatic powder paint coat shall be applied, the contractor shall have a Rugged, fully electronic coating thickness gauges present for testing the thickness of the paint.

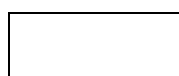
EMCC 7 GENERAL REQUIREMENTS

EMCC 7.1 Internal Wiring

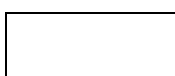
The internal wiring of the boards shall consist of coloured PVC-insulated conductors of adequate copper cross-section, which shall be neatly installed horizontally and vertically in PVC trunking. Numbered ferrules of an approved type (clip on type not acceptable), shall be provided on each end of each wire, to facilitate the tracing of circuits.

Control circuits shall be colour coded as follows;

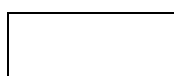
Three Phase	-	Red
Three Phase	-	Blue
Three Phase	-	White
Single Phase	-	Red
A.C. Neutral	-	Black
Earth	-	Green and yellow
110V D.C. Positive	-	Brown
110V D.C. Negative	-	Black



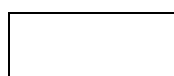
Contractor



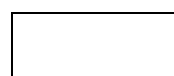
Witness 1



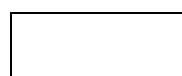
Witness 2



Employer



Witness 1



Witness 2

24V D.C. +ve	-	Grey
24V D.C. -ve	-	Purple
4-20mA +ve	-	White
4-20mA -ve	-	Black
All other voltages	-	To be confirmed with Engineer.

EMCC 7.2 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in a distribution board and motor control centre, this equipment shall be installed in a separate and special compartment.

Sufficient room shall be provided for the rail mounted terminal strips and all wiring shall be terminated on these rail mounted terminal strips for field connection of all monitoring and control cables.

EMCC 7.3 Cable terminations

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end and shall bear the SABS mark of approval. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double inner seals as well as waterproofing seals on nipples.

Cable armouring shall be earthed at each end but may not be used as earth continuity conductor. Flameproof glands for indoor and outdoor use shall be used where the hazardous area classification and explosion protection rating is supplied by the Engineer.

EMCC 7.4 Labelling of Switchboards and Motor Control Boards

A screwed on engraved label of the black on white "traffolyte" type shall be provided below each item of equipment on the front panel of each board as well as on the chassis in close proximity to the relevant equipment to identify such equipment in the English language in 6 mm high lettering.

Each board shall further be provided with a screwed on reverse engraved yellow Perspex nameplate with black 20mm high lettering to identify the board in the English language on the outside of the door at the top thereof.

EMCC 7.5 Motor starter panels

Motor starters shall be contained in its own separate compartment in the motor control board or distribution board.

EMCC 8 MOTOR STARTERS AND ACCESSORIES FOR SWITCHBOARDS

EMCC 8.1 Direct-on-Line starters (400V motors)

These starters shall be of the manually operated (locally and remotely) type and each starter shall be contained in its own separate compartment on the relevant motor control board.

Each of these units shall comprise amongst other the following components:

- a) 1 Only mains **Type 2 Coordinated** fused or circuit breaker switch/circuit breaker connected to the busbars of the board and interlocked with the door of the compartment to prevent opening of the door with the switch closed and to prevent closing of the switch with the door open
- b) 1 Set of HRC control fused links with carriers and basis where necessary;
- c) All necessary relays as required
- d) 1 Only mains **Type 2 Coordinated** contactor;
- e) 1 Set of START and STOP push buttons;
- f) 1 Only mains operated timing device to limit starts per hour; and
- g) 1 Only power factor correction capacitor unit for motors of 5 kW and more.

The following protective and indicating devices complete with the necessary suitably rated potential fuses, current transformers, test blocks and auxiliary relays;

- a) 1 Only electronic type motor protection relay for motors > 7,5kW or more or as specified;
- b) 1 Only motor under current relay (Where specified)
- c) 1 Only instantaneous indicating ammeter for motor current;
- d) 1 Only ammeter selector switch for motors >5 kW;
- e) 3 Only Current transformers for motors > 5 kW;
- f) 1 Only running hour meter;
- g) 1 Only anti-cycle timer; and
- h) 1 Only thermistor relay for motors > 22kW or more
- i) 1 Only Start delay timer for motors >15kW and higher
- j) 1 Only blue LED type indicator light to indicate the time delayed starting period
- k) 4 Only LED type indicator lights as follows; Red – 'Motor Stopped'; Green - 'Motor Running'; Yellow – 'Motor Tripped'; and Red - "Emergency stop engaged". Optional: Yellow - 'Supply on'; Blue – 'Motor start delay'; and Green – 'Healthy'.

It shall further be possible to trip and lock out the starter by means of a remote stop button to be provided at the relevant motor.

Provision shall also be made for locking the mains fused switch handle in the OFF position.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EMCC 8.2 Star/Delta Starters (400V motors)

These starters shall be of the automatic star/delta type and each starter shall be contained in its own separate compartment on the relevant motor control board.

Each of these units shall comprise amongst others provided for direct-on-line starters the following components as:

- a) 1 Only Mains **Type 2 Coordinated** Contactor;
- b) 1 Only Star **Type 2 Coordinated** Contactor;
- c) 1 Only Delta **Type 2 Coordinated** Contactor;
- d) 1 Only Star to Delta timer of the clockwork or electromagnetic type;
- e) 1 Only Mains operated timing device to limit the starts per hour;
- f) 1 Set START and STOP pushbuttons
- g) 1 Only Three phase Power Factor Correction Capacitor unit for motors of 5kW or more
- h) All necessary relays

EMCC 8.3 Variable Speed Drives

These variable speed drives shall each be contained in its own separate panel, manufactured and equipped to the satisfaction of the variable speed drive manufacturer to suit their own requirements with regard to ventilation of the variable speed drive. Small drives below 1kW can be combined into one panel but sufficient ventilation by means of extractor fans must always be allowed for

The variable speed drive panel shall be equipped with ventilation fans and air filters. The ventilation fan shall be interlocked with the relevant motor and shall only be in operation when the motor is running. Failure of the ventilation fan shall stop the motor and a visible indication of the cause of the failure shall be provided on the panel.

The frequency converter shall make use of flux vector control without encoder or tacho generator feedback and shall incorporate direct torque control technology so that the overall effectiveness of the drive shall only be limited by the performance of the motor.

Semi-conductor switching shall be determined by the values of flux and torque and shall not have a predetermined pattern as in conventional pulse width modulation flux vector drives.

Each of these drives shall comprise amongst others the following components:

- a) 1 Only main isolator/circuit breaker that shall be interlocked with the door of the panel to prevent opening of the door with the switch closed and to prevent closing of the switch with the door open
- b) 3 Only ultra rapid fuses rigidly connected to the load side of the above mentioned mains isolator and the rating of which shall comply with the manufacturers specifications for the drive
- c) 1 Only direct torque control frequency converter

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- d) 1Only door mounted control panel complete with cable connections (also for small drives)
- e) 1Set of START and STOP push buttons for manual control of small drives
- f) One dial type potentiometer for manual speed control.
- g) 1Only manual/off/auto selector switch for manual control of small drives
- h) 1Only Thermistor relay for motors of 22kW or more
- i) 1Only external EMC line filter
- j) All equipment necessary for remote emergency stop device.
- k) All bus system interface equipment necessary for remote speed control via a monitoring and control SCADA system as well as PLC control.
- l) All equipment necessary for remote motor status and speed monitoring.
- m) 4Only LED type indicator lights as follows; Red – 'Motor Stopped'; Green - 'Motor Running'; Yellow – 'Motor Tripped'; and Red - "Emergency stop engaged". Optional: Yellow - 'Supply on'; Blue – 'Motor start delay'; and Green – 'Healthy'.

A 3CR12 steel gland plate must be provided at least 250mm above floor level for cable connections.

The control panel shall be the user interface for monitoring, adjusting parameters and controlling the drive operation. It shall be possible to:

- a) Enter start-up data into the drive.
- b) Control the drive with start, stop and reference signals.
- c) Display actual values of motor performance.
- d) Display information on at least the five most recent faults.
- e) The drive shall satisfy the following technical requirements.
- f) The static speed control error shall not exceed $\pm 0,5\%$ of motor nominal speed.
- g) Fundamental power factor shall be at least 0,97 at nominal load.
- h) Efficiency shall be at least 98% at nominal power level.
- i) The drive shall operate satisfactorily under all ambient temperature conditions between - 5°C and + 40°C at an altitude of 1260m above sea level and humidity up to saturation point.
- j) The drive shall provide output protection for motor overload, over current, short circuit at start, earth fault, missing motor phase and over frequency.
- k) The drive shall satisfy the following minimum harmonic voltage limits: Total harmonic distortion of 6%, odd harmonic distortion of 4% and even harmonic distortion of 2%. The Contractor shall measure these harmonic distortion parameters after commissioning of the system and if the equipment fails to comply with this requirement, the Contractor will have to rectify the same to the satisfaction of the Engineer.
- l) The drive shall be equipped with an AC choke for harmonic current reduction and shall be placed on the AC side of the rectifier bridge in order to protect the rectifier semiconductors against power line transients.
- m) Torque step rise time shall typically be less than 5ms.
- n) Stringent precautions must be taken in the design of the protection equipment to assure adequate lightning and surge protection.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMCC 8.4 Electronic Soft Starters

The soft starter shall be installed in the relevant motor starter panel but sufficient ventilation by means of extractor fans must always be allowed for and shall be interlocked with the relevant motor and shall only be in operation when the motor is running. A bypass contactor for motor running conditions is a requirement and shall either form part of the soft starter or shall be a separate unit.

The soft starter shall have soft start and stop programmable capabilities with torque and current control. The normal motor protection facilities such as over/under-current, start limit, long start time, electronic overload, phase loss and phase sequence and load loss shall be available.

At least a 2 line 16 character LCD display unit with control function keys shall form part of the soft starter and shall preferably be separate motor starter front panel mountable. The LCD unit shall display all statistical data and trip conditions and shall allow functional key changes to programmable parameters.

The full motor protection capabilities shall be maintained when motor is operating in bypass contactor mode.

RS 485, MODBUS, PROFIBUS communication shall be possible.

EMCC 8.5 Induction Soft Starters

The induction type soft starter shall be installed in the relevant motor starter panel but sufficient ventilation by means of extractor fans must always be allowed for and shall be interlocked with the relevant motor and shall only be in operation when the motor is running. A bypass contactor shall be provided to bypass the soft starter.

The series impedance type starter shall incorporate reduced starting current and ensure gradual increase in the motor terminal voltage in smooth step-less manner.

The design of the induction soft starter shall allow the motor to generate adequate starting torque to overcome the load torque and friction to ensure smooth acceleration.

The soft starter shall allow five starts per hour.

EMCC 8.6 Mains surge arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures requirements. All surge arrestors shall be connection type 2 as per the latest addition of the SANS 10142.

EMCC 8.6.1 Building With external lightning protection

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EMCC 8.6.2 Building With NO lightning protection

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EMCC 8.7 Moulded case circuit breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with the requirements of SANS Specification no. 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.

Each circuit breaker shall be provided with non-adjustable time-delayed trips.

These circuit breakers shall be fitted with copper terminal collector bars where more than one cable tail has to be terminated on the same terminal.

EMCC 8.8 Fused switches

All fused switches shall be of the "load-breaking" and "fault-making" type complying with BS-5419 where applicable and fitted with HRC cartridge fused links to BSS-88. Auxiliary contacts shall be provided where relevant for signal purposes.

EMCC 8.9 Current limiting circuit breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200 kA rms at least three times.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The current limiting circuit breaker shall be equal and similar to the specified Merlin Gerin type.

EMCC 8.10 Current transformers

All current transformers shall be of the air insulated type complying in all respects with the requirements laid down in BS 3938: 1973.

The contractor shall carefully select the ratio, burden and accuracy class to suit its specific application in accordance with the recommendations and requirements of BS 3938.

EMCC 8.11 Indicating instruments

All indicating instruments shall comply with the requirements laid down in BS 89: Part I: 1970 for instruments of a 2,5 Accuracy Class. All indicating instruments shall have 96mm square dials.

The maximum demand ammeters shall be of the 6A combined maximum demand registering and instantaneous indicating type having MISC movement and thermal demand indication with an integrating time lag of 15 minutes. The ammeter scales shall be direct reading with a full-scale deflection corresponding to 120% of the rated primary current of the relevant current transformer. Each ammeter shall be clearly and indelibly marked to indicate the colour of the phase to which it is connected.

The ammeters for motor starters shall be 5A instantaneous indicating meters with MISC movement and direct reading scales. The meters shall be able to withstand over currents resulting under starting conditions and the full load current of the relevant motor shall be clearly marked in red on the face of the meter.

Voltmeters shall be of the direct reading moving iron suppressed zero type.

The power factor meters shall indicate from 0,7 lagging to 0,7 leading.

The running hour meters shall have cyclometer dials indicating up to 5 digits and two decimals. (12345,67)

EMCC 8.12 Instrument selector switch

A four-position rotary type instrument selector switch shall be mounted directly below the relevant instrument in such a way that only the selector knob and indicator plate are on the panel, and the switch itself is behind the panel.

The selector knob shall consist of Bakelite, and shall have an arrow engraved on it, indicating the switch position.

The switch shall have a positively driven switching mechanism.

The indicator plate shall consist of Bakelite and shall have the positions for the three phases and "OFF", engraved on it in 5mm high lettering.

EMCC 8.13 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "CLASS II MECHANICAL DUTY CLASS / TYPE 2 COORDINATION" and "A3 Make and Break Category".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EMCC 8.14 Time switches

The time switches shall be suitable for use on a 231 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 231 V.

EMCC 8.15 Isolators

All isolators shall be of the "Load-breaking" and "fault making" type and shall comply with the requirements of BS 5419-1977 where applicable. Where relevant, isolators shall be provided with auxiliary contacts for signal purposes.

EMCC 8.16 400 Volt air-break contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of IEC 158-1 for Class AC 3 contactors of Intermittent Duty Class 0,3.

All contactors shall be provided with arc extinguisher and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Each contactor shall be provided with a 240 Volt, 50 Hz closing coil suitable for continuous operation and at least 15 closing operations per hour. In rural areas contactor coils must be rated to operate satisfactorily between 75% and 130% of nominal voltage.

An adequate number of auxiliary contacts shall be fitted.

The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EMCC 8.17 Earth leakage units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

EMCC 8.18 Terminals

Terminals may be of the bolted type otherwise they shall be of rail mounted clamp type.

All types of terminals and their insulation shall have a minimum comparative creep index of 500 to BS 3781.

EMCC 8.19 Clamp type terminals

These terminals shall be not less than 8 mm wide.

Screws and connectors shall be electroplated to prevent corrosion. The connectors shall be such that the screws will not loosen due to vibration. Current carrying parts shall be of serrated silver plated copper or brass. Only one connection shall be allowed per connector. For more connections the number of terminals shall be increased and bridge pieces shall be used.

EMCC 8.20 Surge Protection

EMCC 8.20.1 Surge Arrestors

Surge arrestors shall be supplied and installed under this contract where applicable.

EMCC 8.20.2 Main supply protection

Surge arrestors as specified shall be installed at the main incomer of each distribution board, motor control centre or any type of kiosk.

EMCC 8.21 Power factor correction capacitors for 400 Volt motors

Each of these capacitors shall be of the indoor switchboard mounting 400 Volt 50 cps three-phase self-contained type with a dead casing and shall fully comply with the requirements laid down in BS 1650-1971.

Each capacitor unit shall be of carefully selected rating to correct the power factor of its associated motor to 0,95 at full load and should not exceed a value which compensates for 85% of the no-load magnetizing current.

The dielectric shall consist of plastic film and low-loss paper situated between aluminium foil and impregnated with a synthetic liquid agent with scavenger additive.

The capacitor losses shall not exceed 1 Watt/kV.Ar.

The capacitor units shall have the following admissible overloads at an ambient temperature of 40°C and an altitude 260 m above sea level.

10% excess volts continuously;
50% excess current continuously; and

30% excess kV.Ar continuously.
Each of these capacitor units shall be provided with discharge resistors and a fuse in each winding element that will disconnect the affected element in event of a di-electric breakdown. A time controlled contactor shall connect and disconnect the capacitors to the starter control circuit.

EMCC 9 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door of an outdoor motor control centre or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EMCC 10 ELECTRONIC LEVEL CONTROL

The micro based electronic controllers which will be mounted in the starter panels shall be easy to calibrate and reliable in service.

The power units for all the pumps in a specific pump station shall be installed in a separate compartment of the starter panel and clearly labeled in accordance with the pumps it controls.

These level controls shall be designed to automatically select the pump sequence to ensure that all the pumps will at random be a duty pump.

Where a controller controls only two pumps and one pump is always a standby pump, the standby pump shall automatically become the next duty pump after each duty cycle, unless one pump is taken down for service. When that occurs, the duty pump shall remain on duty until the normal operation is restored.

When a pump selected for duty fails to respond to the start signal from the control, then the next duty pump shall automatically start-up after five minutes.

The level controller must also stop all the pumps, whether on manual or automatic selection, when the pump has reached a predetermined low level.

The transducers shall be designed to operate in air, been capsulated, of rugged construction and impervious to submergence. The transducer shall not form part of the MCC scope of supply

The coaxial cable between the transducer and power unit shall be of sufficient length to avoid any joints in this cable, as no joints will be permissible.

EMCC 11 EMERGENCY STOP PUSH BUTTONS AND WEATHERPROOF ISOLATORS

Each of these units shall consist of a totally enclosed outdoor type heavy duty "push and turn to lock" stop push button station with a cable gland entry at the bottom to accommodate a 4 core 2,5mm² LT PVC SWA PVC cable.

Where installed at motor positions the emergency stop push buttons shall not form part of the MCC scope of supply.

EMCC 12 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

Earth resistivity measurements of less than 1 ohm will be acceptable at motor control centres and distribution boards.

EMCC 13 INFORMATION TO BE SUBMITTED WITH TENDERS IN RESPECT OF THE 400 VOLT DISTRIBUTION BOARDS AND MOTOR CONTROL BOARDS.

The following information shall be submitted with each Tender in respect of all boards offered:

- a) Full technical details and descriptive literature regarding all equipment and instruments offered;
- b) Three paper prints of an outline drawing of each motor control centre and distribution board indicating the main overall dimensions and general lay-out of the boards; and
- c) Three paper prints of an outline drawing of the front end processor cabinet indicating the main overall dimensions, general layout and type of material employed on the face of the panel.

EMCC 14 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

- a) Wiring diagrams of all motor control centres and distribution boards.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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- b) Schematic single line diagrams of all motor control centres and distribution boards.
- c) Elevations showing dimensional information including details such as, but not limited to, the following:
 - motor control centres and distribution boards height (less any removable lifting angles or eyes)
 - motor control centres and distribution boards width
 - motor control centres and distribution boards depth
 - Location of shipping splits
- d) Structure descriptions showing the following:
 - Bus ratings
 - Enclosure ratings
 - Short-circuit withstand ratings
 - Other information as required for approval
- e) Conduit locations
- f) Required bus splices
- g) Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous ampere ratings, and pilot devices
- h) Nameplate information
- i) Manufacturer drawings shall be provided in PDF format
- j) Data sheets and publications on all major components including, but not limited to, the following:
 - Motor starters
 - Overload relays
 - Circuit breaker and fuse information including time current characteristics
 - Control power transformers
 - Pilot devices
 - Relays
 - All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

EMCC 15 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

EMCC 16 TESTING OF DISTRIBUTION/MOTOR CONTROL BOARDS AT THE MANUFACTURER'S WORKS

Each distribution/motor control board shall be subjected to the following tests in the manufacturer's works after manufacture:

- a) A thorough inspection shall be carried out to ensure compliance with the specification and approved drawings and wiring diagrams and to ascertain that all connections are properly made.
- b) A high voltage test on all primary connections to check the insulation between phases mutually and between each phase and earth.
- c) The polarities and ratios of all potential and current transformers shall be checked.
- d) Primary and secondary injection tests shall be carried out on all switching, protection, metering interlocking and indication circuits.

The manufacturer shall submit three copies of test certificates giving details of conditions and results of tests carried out to the Engineer.

EMCC 17 CONCRETE PLINTH FOR OUTDOOR STARTER PANELS AND PEDESTALS

The plinth shall be cast 150mm below as well as 150mm above the ground level. It shall have neatly bevelled edges and shall be 75mm wider than the panels all round.

An opening of sufficient width to allow for cable entry shall be provided under the starter panels.

The grade 304 stainless steel foundation bolts for mounting of the panels shall be cast or grouted into the plinth. The plinth shall be in Class 20/19 concrete and shall be suitably reinforced if necessary.

It is recommended that the casting of these foundations must be carried out by the Civil Contractor at the cost of the Contractor under this Contract in accordance with his instructions and under his supervision.

EMCC 18 INSTALLATION OF DISTRIBUTION BOARDS AND MOTOR CONTROL BOARDS

Each of the relevant distribution boards and motor control boards shall be built into walls or securely bolted down on the floor or plinth, as may be required, by means of the requisite number of foundation bolts grouted into the floor in the positions indicated on the drawings.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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These positions shall be confirmed with the Engineer on site, prior to installation.

- a) Contractor shall install MCC in accordance with manufacturer’s instructions.
- b) Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer’s torque requirements.
- c) Contractor shall select and install fuses in fusible switches based upon field requirements.
- d) Contractor shall adjust circuit breaker settings based upon field requirements.
- e) Contractor shall adjust solid state overloads to match the installed motor characteristics.

EMCC 19 TESTING AND COMMISSIONING OF DB/MCC AFTER INSTALLATION ON SITE

After installation on site but prior to commissioning the following inspections and tests shall be performed on each distribution/motor control board.

- a) Check all components to ensure that they are free from dust and protective packing material;
- b) Check the operation of all components liable to damage in transit such as meter and protection measured;
- c) The insulation of all primary circuits between phases mutually and between each phase and earth shall be measured;
- d) All fused links shall be checked for electrical continuity; and
- e) All control supplies shall be checked.
- f) All adjustable protection devices shall then be set and the boards commissioned all in consultation with and to the instruction of the Engineer.

EMCC 20 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x “soft copies” of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick).

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard

pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EMCC 21 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EMCC 21.1 Design, Drawing and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For motor control centres and distribution board’s installation, design information shall include, but limited to as listed in this Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide MCC design drawings and wiring diagrams as specified	Sum
(b) Provide operating and maintenance manuals and “as built” drawings as specified	Sum

EMCC 21.2 SUPPLY AND DELIVERY TO SITE

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For motor control centres and distribution boards, the rate tendered shall be for the complete motor control centres and distribution board’s and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of a complete MCC	Each

EMCC 21.3 INSTALLATION

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

Install of motor control centre and switchgear shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the motor control centres and distribution board’s installation switchgear complies with the requirements and serves the intended purposes.

Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of motor control centres and distribution board's installation but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of MCC	Each

EMCC 21.4 COMMISSIONING

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of MCC	Each

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

EPLC ELECTRICAL/ELECTRONIC: PROGRAMMABLE LOGIC CONTROLLERS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



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EPLC ELECTRICAL/ELECTRONIC: PROGRAMMABLE LOGIC CONTROLLERS

EPLC 1 SCOPE OF WORKS

As specified in the Project Specifications.

EPLC 2 CONDITIONS TO SERVICE

The PLC Units will be installed inside MCC (Motor Control Centres) Panels and/or in the PLC cabinets where required. The typical areas where PLC installation shall be required are the following:

- An industrial WTP (Water Treatment Plant)
- An industrial WWTP (Wastewater Treatment Plant)
- A Pipeline Project with Pump Stations/Reservoirs/Feeder Tanks, etc.
- Mining areas
- Power Plants
- Substations
- And all subsequent areas where Control Systems are required

EPLC 2.1 Abbreviations

PLC	-	Programmable Logic Controller
CPU	-	Central Processing Unit
HMI	-	Human Machine Interface
UPS	-	Uninterrupted Power Supply
SFC	-	Sequential Function Chart
SRS	-	Software Requirements Specification
I/O	-	Input and/or Output (Analog and/or digital)
CF	-	Control Function
CFS	-	Control Function Section
CSC	-	Computer Software Configuration item
CSC	-	Computer Software Component
CSU	-	Computer Software Unit

EPLC 3 STANDARDS AND TESTS

All materials and equipment to be supplied and installed under this contract shall be new and of the best quality available, as specified.

All materials and equipment shall comply with the requirements laid down in the latest editions of the BS, SANS and IEC specifications and their amendments (if any) as well as those laid down in this specification. All material and equipment shall bare the SABS mark, if material and equipment are offered not baring the mark, test certificates shall be submitted from independent testing agent, of the standard compliance of equipment.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The workmanship and finish of work shall be of a high standard throughout and to the satisfaction of the Engineer.

Similar equipment supplied under this contract must be identical in all respects and it shall be possible to interchange any of the same equipment under this contract.

a) Compliance with Laws and Regulations

The work shall be carried out strictly in accordance with and all material and equipment supplied shall comply with the following laws and regulations (the latest edition) of the where applicable:

- "Code of Practice for the Wiring of Premises", SANS 10142, as amended;
- The machinery and Occupational Safety Act (Act No 6 of 1983) as amended;
- The "Electrical Supply By laws and Regulations" of the Supply Authority;
- The local Fire Office Regulations;
- The Post Office Regulations;
- "Code of Practice for the Installations and Maintenance of Electrical Equipment used in Explosive Atmospheres" (SABS 086).

The Contractor shall be responsible for serving all notices and paying all fees due in terms of the above laws and regulations.

b) Standard Specifications

The work shall be carried out strictly in accordance with and all material and equipment supplied shall comply with The Occupational Health and Safety Act (Act No. 85 of 1993) as amended.

The following Standard Specifications and drawings shall apply:

- | | | |
|-------------|---|------------------------------------------------------------------------------------|
| SANS 156 | - | Moulded Case Circuit Breakers |
| SANS 1574 | - | Electric cables and flexible cords |
| NRS 002 | - | Graphical symbols for electrical power, telecommunications and electronic diagrams |
| SANS 1433-1 | - | Terminal blocks having screw and screw-less terminals |
| SANS 1433-2 | - | Flat push-on connectors |
| IEC 68 | - | Shock and vibration resistance |
| IEC 1000 | - | Electrostatic discharge and electromagnetic interference |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

IEC 1131 - Standard software

EPLC 4 RADIO AND TV INTERFERENCE

All equipment installed under this Contract shall comply with the Government Notice No R.2246 and any other applicable codes, rules and/or regulations in respect of radio and TV interference.

Any equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost.

EPLC 5 PROGRAMMING AND CONFIGUTATION

a) Programmable logic software

All PLC software shall be structured in a logical manner representing the key process units and control regimes required for plant control.

b) Programming

The contractor shall program the PLC including all functions and operations to comply with the plant and/or pump control philosophy and/or any other equipment as provided by the engineer. The contractor shall insure that at tender stage they are familiar with the standards and protocols used by the client and shall allow for adaptability of the offered system. The client’s standard IP addressing and network configuration shall be used to ensure smooth integration.

c) Execution of control regimes

Control programs shall be executed at PLC level always. Approval to execute any control functions at supervisory level shall be obtained from the Engineer before commencement of the development of the software.

d) Configuration

Where required, the contractor shall allow for the following scenario:

- i) Interface and configuration to an existing SCADA System, as per the existing Client’s specification, and shall include all the relevant graphics required for integration to the new equipment.

A system specialist shall be required to complete this task and the contractor shall allow adequate time to complete, test (FAT), pre-commission and commission the complete integrated system, consisting of both the new and the old installations.

EPLC 6 PROGRAMMABLE LOGIC CONTROLLER HARDWARE

EPLC 6.1 Hardware Configuration

Normally the hardware configuration will be a single CPU with I/O modules as required mounted on a 19-inch rack back plane.

Where required, Remote I/O shall be installed within close proximity to a PLC unit. Based on the distance between the Remote I/O unit and PLC unit, this shall determine which physical media type is to be used (Multimode Fibre Optic or Ethernet CAT5e).

All designs shall be backed up with design calculations, compliance to network standards and compliance to international communication standards and protocols (ANSI, IEEE, IEC, etc.)

EPLC 6.2 Enclosures

PLC/Remote I/O equipment shall be mounted in an IP54 enclosure with a suitable viewing window in front of the modules. The enclosure will form part of the MCC (Motor Control Centre) and in the event that no MCC is available a separate enclosure shall be supplied.

EPLC 6.3 General

The unit shall comprise of a PLC with interface modules, a power supply, input and output modules, network modules and shall be suitable for 19 inch rack mounting, unless specified differently by the Engineer. All equipment shall be housed in a steel cabinet that will form part of that specific MCC unless the application requires a separate control cabinet installation.

The technical requirements for the different modules forming part of the overall PLC System are discussed below:

EPLC 6.4 Power Supply

The standalone single slot rack mounted power supplies shall operate from 24VAC/24VDC/230VAC and shall have sufficient capacity for the application. The Power Supply module shall be fed by a regulated UPS supply. The power supply shall provide all regulated DC back plane power necessary for all the installed modules. The power supply shall have over and under voltage protection for added security.

The stand-alone single slot rack mounted power supplies shall operate from UPS fed - 230 V-AC and be sufficiently sized based on the requirements of this project in terms of its power capacity.

The UPS backup shall provide power for a minimum duration period of one hour.

The power supply shall provide all regulated DC back plane power necessary for the installed modules.

The power supply shall have over and under voltage protection for added security.

Allowed interruptions of power supply should DC and AC power supplies should be less than 10mS and 0.5 seconds respectively.

EPLC 6.5 CPU

The CPU module shall be a back plane slot mounted controller containing on board executive memory, application memory and communication ports. It shall be possible to perform field upgrades through a field bus communications port. The front panel of the CPU shall be equipped with status and fault LED's to facilitate fault diagnostic procedures. The CPU shall have a multipoint interface for an external programming device as well as an Ethernet RJ45 port.

The technical specifications of the CPU Unit (unless specified differently by the Engineer) shall be as follows:

- The CPU should have the following minimum processing times for:
 - a. Bit operations : ≤ 50 nanoseconds
 - b. Word operations : ≤ 60 nanoseconds
 - c. Fixed point arithmetic operations : ≤ 80 nanoseconds
 - d. Floating point arithmetic operations : ≤ 300 nanoseconds
- The CPU should have minimum IP20 degree of protection
- The CPU shall have a real time clock for the generation of time related information
- The CPU shall have surge protection
- The CPU shall have diagnostics like alarms (including diagnostic alarm, hardware interrupts, wire break)
- The CPU shall have diagnostics indication LEDs (including run, stop, error, send, receive, etc.)
- The CPU shall have shock resistance according to IEC 60068-2-27.
- The CPU module shall be a back plane slot mounted controller containing the required integrated program memory and data memory.
- Sufficient programming memory and a processor with a very fast processing speed shall be made available.
- The programming memory shall have 30% spare capacity, after all the required design requirements have been met.
- The size of the processor selected shall be done such that the utilization factor will be at most 70% of its processing (CPU clock speed) capability. This then leaves at a minimum 30% available processing capability for future expansion
- **Note:** The proof of the CPU Utilization factor (based on the current I/O requirements), for each individual CPU Unit is required by the Engineer and shall form part of the overall Data Pack.
- Ethernet and engineering interface communication ports must be available on the CPU
- It shall be possible to perform field upgrades, as well as firmware upgrades, through the

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Field bus communications port/Ethernet port

- The CPU shall support at least the following **IEC 1131-3** programming languages:
 - Sequential Function Chart;
 - Structured control language (SCL)
 - Function Block Diagram
 - Ladder Diagram
 - Structure Text
 - Instruction List
- The CPU shall be equipped with either a lithium battery or an internal energy storage element, for backing up the RAM holding application programs

EPLC 6.6 Communications Processor

- The communications processor shall provide communication links with other programmable controllers to other required network communication (i.e. PROFIBUS, Industrial Ethernet) connections apart from the PLC CPU communication interfaces.

EPLC 6.7 Software (General)

- All PLC software shall be structured in a logical manner representing the key process units and control regimes required for plant control.
- System diagnostics should provide all relevant information regarding errors present in the system; also, the software should allow automatic updating of the system diagnostics when modifying the hardware configuration and also fast fault localization.
- All PLC software shall be fully documented and the documentation shall consist of the following as a minimum:
 - Functional specification of the plant to be controlled
 - Process control logic diagrams
 - Sample report forms
 - Sample alarm report details (list and format of reports)
 - Fully annotated listing of the full software package
 - Full input/output listings
 - Full allocated register listing with functional description
 - Program software in electronic format
 - All documentation is subject to the approval of the Electrical Engineer.

EPLC 6.8 Software (Development)

- The Sequential Function Chart (SFC) language, used to structure the internal organization of a program, and four inter-operable programming languages: Instruction List (IL), Structured Control Language (SCL), Ladder Diagram (LD), Function Block Diagram (FBD) and Structured Text (ST) should correspond to the textual high-level language ST (Structured Text) defined in the standard IEC 61131-3 and fulfils base level and reusability

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

level requirements according to PLC open standard

EPLC 6.9 Digital I/O Modules

- The digital I/O modules shall accept inputs from plant controls and auxiliary multiple operations and provide control outputs to plant operations.
- The modules shall be complete with I/O connectors. 24VDC input and output modules will be preferred.
- These modules shall also be capable to accept floating alarms of duration of 20 milliseconds. as well as steady alarms from normally closed controls.
- A typical response time of 1ms for change of state shall be acceptable.
- All inputs and outputs shall be 2,5 kV isolated from the logic components.

EPLC 6.10 Analogue I/O Modules

- These modules shall accept analogue inputs from plant transducers and provide control analogue outputs to plant operations and shall be capable of converting 0-5V, 0-10V, 0-20mA or 4-20mA signals as may be required.
- All analogue inputs and outputs shall be galvanically isolated.
- The input modules shall have a typical accuracy of at least $\pm 0.05\%$ of full scale while the accuracy of the output modules shall not exceed $\pm 0.2\%$ of full scale.
- The input modules shall have broken wire fault detection capabilities, diagnostic functions, monitoring the supply voltage, should have an IP20 degree of protection, diagnostic functions, Diagnostic LEDs for status of inputs and maintenance

EPLC 6.11 Distributed (Remote) I/O Modules

- The distributed I/O module shall be a standalone unit with an integral 230V AC power supply and equipped with digital and analogue I/O as listed in the attached I/O list. The module shall, preferably, have an Ethernet port and the distributed I/O module should have minimum IP20 degree of protection
- The distributed I/O module shall be connected via Ethernet/IP to the main PLC unit
- The Engineer must firstly approve if the contractor offers an alternate communication protocol (for e.g. PROFIBUS, PROFINET, EtherNet/IP, Modbus TCP/IP, etc.)

EPLC 6.12 Optical Link Modules

The back plane mounted optical link modules for fibre optic cables shall allow networks to be configured in linear, ring and star structures and shall be supplied complete with the necessary cable connectors, interface cards and bus connectors.

Contractor

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EPLC 6.13 Fibre optic to RJ45 converters

Where specified fibre optic to RJ45 converters shall be installed. These units shall be secured in an acceptable manner.

EPLC 6.14 Distributed I/O

The distributed I/O module shall be a standalone unit with an integral 230V AC power supply and equipped with digital and analogue I/O as may be required. The module shall have an Ethernet port (unless specified differently by the Engineer)

EPLC 6.15 I/O Allocations for Plant Availability

The allocation of input and outputs shall be in a logical manner. The allocation shall be on the basis of process units or streams or drives such that the failure of a card will cause minimum loss of plant availability.

Specifically for any motor starter the inputs shall be grouped on one card. The number of inputs allocated to a motor starter is such that they can be grouped on a 16/32 way digital input card and/or 4/8 way analogue input card so that at most two motor starters are allocated to one card. The allocation of inputs and outputs for motor starters shall be such that a duty and standby motor starter are not together on the same I/O cards.

EPLC 6.16 Documentation

All PLC hardware and software shall be fully documented and the documentation shall consist of the following as a minimum:

- Functional specification of the plant to be controlled
- All proposed PID Loops including diagrams
- Process control logic diagrams
- All Loop diagrams
- Layout/images of Graphical Faceplates for proposed Plant Sites
- Sample report forms
- Layouts of proposed Trending Faceplates
- Sample Alarm report details (list and format of reports)
- Fully annotated listing of the full software packages
- Full input/output listings
- Full allocated register listing with functional description
- Program software in electronic format
- All documentation is subject to the approval of the Electrical Engineer.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EPLC 7 COMMUNICATION

EPLC 7.1 General

PLC communication shall utilize Ethernet as a standard, unless another standard is specifically mentioned by the Engineer.

The Contractor shall list three different protocols they intend using over the Ethernet physical standard. The Contractor shall ensure that the three different protocols they select, are not only compliant with their own equipment but with all the major Control System equipment suppliers (Siemens, Honeywell, Rockwell, Schneider, ABB, GE, Mitsubishi, etc.) as well.

The Contractor may give their preference for any of the three protocols selected, but must include valid reasons for their choice. The Engineer however reserves the right to decide which protocol shall be best suited to the installation requirements.

EPLC 8 INTERLOCKING CONTROL USING COMMUNICATION NETWORKS

Where it is necessary to execute process control on a PLC and/or supervisory network the following shall apply:-

Safety interlocks where human or equipment safety is a criterion may be communicated over a PLC to PLC network. The interlocks may not be communicated over a higher level supervisory network. This requirement does not negate the requirement to have hardwired safety stop controls on all drives and switchgear.

Non-essential interlocks, the failure of which will not cause harm to persons or equipment may be communicated with prior permission over a supervisory communications network. Preference, however, is to keep all interlocking at the field bus or Ethernet level unless rate of communication is compromised due to excessive traffic levels.

Data for the purpose of reporting and management information shall be channelled through the supervisory level network (Full duplex Ethernet Network). Such data shall preferably not be transmitted on the field bus or Ethernet sub-network level unless a supervisory level channel is not available for this purpose.

EPLC 9 HARDWARE CONFIGURATION UNIT BASIS

Hardware shall be configured on a per "unit" basis, which means each pump set shall be configured in a module with equipment dedicated to that pump set only. It shall be configured on a unit by unit basis only, thus ensuring that the failure of any one item will affect only a single pump set at any instant in time.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

It may however, be necessary to serve a pump set PLC hardware with common services such as UPS (Uninterruptible Power Supplies) Units.

For this purpose the pump sets shall be provided with the following:

- A control console located on the operating floor in a position where the operator is able to overlook the pump sets, unless otherwise specified.
- A HMI (Human Machine Interface) terminal is required to display all process and fault information, unless otherwise specified. The normal control functions shall be executed by way of soft keys on the HMI Unit.
- An "Emergency Stop" push button for each pump set in the pump station mounted on the control console, unless otherwise specified. The emergency stop push button shall have a red mushroom operator and shall be of the latching, twist to release type.
- Stop circuits shall be hardwired in the main circuit breaker control circuit as the primary trip route and shall also be wired into the PLC control circuit.
- Emergency trip push buttons shall activate both the trip coil and no volt release coil of the main circuit breaker or contactor where used.

EPLC 10 HMI TERMINAL - PROCESS INFORMATION

The monitoring and control functions of each pump set shall be accessible on the HMI.

The device shall be programmed that the control soft keys of each pump set are the same. To ensure that this requirement is maintained, a standard software package shall be applied to each pump set. Variable speed pump sets shall have the facility for speed adjustment added.

The HMI shall have a minimum 10,4 inch colour screen and HD definition pixilation. Sufficient application memory shall be available to ensure at least 50% spare memory with the required applications loaded. The HMI shall be equipped with an Ethernet port for PLC communication.

As a minimum, the following basic process information shall be displayed for each pump set or pump stage as applicable:

Operating Parameters

- Suction pressure
- Delivery pressure
- Delivery flow rate
- Running hours - accumulated total and since last start
- Accumulated kWh
- Tank Levels
- Hour operational schedule

Valve Parameters

- Suction valve position indication

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- Delivery valve position indication

Pump Parameters

- DE and NDE bearing temperatures
- Thrust bearing temperature
- Vibration measurement (vertical, horizontal and axial directions)
- Volute temperature

Motor Parameters

- DE and NDE bearing temperatures
- Phase stator temperatures
- Motor power
- Motor current
- Motor speed (variable speed drives only)
- Power factor (variable speed drives)
- Vibration measurement (vertical, horizontal and axial directions)

Auxiliary Devices

- Device run and stop indication
- Device fault indication
- Flood alarm

The following basic information Faceplate screens shall also be provided

- Faceplates showing process information for each individual pump
- Faceplate showing overview of pump sets
- Faceplates for each Area or Sub-area
- Faceplates for Auxiliary Systems (CP, AC Mitigation Systems, etc.)
- Faceplates for Auxiliary Systems (Fire Detection, Intruder Detection)
- Faceplates for Alarming
- Faceplates for trending
- Faceplate for all MV Protection settings and adjustments
- Faceplates for all interlocks (Hardwired & "Soft" wired)
- Faceplate showing a main Overview of entire process
- Faceplate for main 11kV electrical power supply system with status indication for all circuit breakers and associated equipment.

EPLC 11 SCADA INTERFACE

To facilitate an interface with a SCADA system the PLC's shall all have Ethernet communication ports as a minimum requirement, unless specified differently. Depending if sub-networks are required, field bus communication ports shall also be required.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The intention is that all main water pump sets be controlled from the relevant local control panel as well as from the SCADA system. However, process data will be collected utilizing the Ethernet standard for information, control, alarming, reporting and trending on the SCADA system.

Provision shall be made for control of the pump sets via the SCADA system by means of a selector switch panel on the motor starter panel located in the pump station which shall have the functions – **Remote Mode / Local Mode / Maintenance Mode**, unless otherwise specified. Switching of this selector switch while a pump is running shall not trip the relevant motor.

EPLC 12 TERMINAL STRIPS IN PLC PANELS.

Wiring directly to the PLC I/O cards is not permitted. All wiring shall be by way of two sets of terminals arranged such that one set of terminals are grouped on a cable by cable basis and the second set of terminals reflect the PLC I/O card slots. Patch wiring shall be provided between each of the terminal strips as required.

Terminals used in PLC cubicles shall be of the knife type, unless specified differently.

EPLC 13 PLC SOFTWARE DEVELOPMENT

EPLC 13.1 Software

IEC 1131 Standard software with up and down load capabilities programmable over the Ethernet network and complies with a standard Graphical User Interface 64/128 bit operating system for network applications, shall be used.

The software shall allow the reusability of function blocks as building blocks in future applications and shall have a built-in PLC simulator that will allow the running of the IEC program for debugging purposes.

EPLC 14 IDENTIFICATION

This specification describes the procedure for the development of PLC software. All PLC software developed shall conform to the conventions and standards described in this procedure. The documents described in this procedure shall be produced as outputs during the software development process, and together they will enable the maintenance and re-use of software, and they will simplify configuration management of software items.

EPLC 15 SOFTWARE ENGINEERING REQUIREMENTS

PLC software shall be designed for continuous reliable operation.

The software shall be designed for maintainability. This particular requirement enforces the following constraints on the software development:

It shall be possible to change the software in response to changing requirements by modifying only those sections of code that are directly related to the change in process requirements.

The code shall be written on the premise that it shall be possible to make changes to local code sections without affecting the functionality of other code.

The program style shall be direct and simple wherever possible. This will enable future modifications to be performed by programmers that may not have been involved in the development of the original system. Convoluted programming techniques shall not be used.

Convoluted programming techniques tend to mask the essential design of the program. Such techniques shall only be used when the programmer has no alternative, or when the benefit (efficiency, size, execution time etc.) significantly outweighs the cost.

All PLC programs shall be extensively documented to convey the intended function of the program. The intended function of the PLC programs shall therefore be very well described in the documentation, thus allowing for the total understanding of what the PLC programmer intended to achieve with the PLC program. Copies of the PLC programs (both soft copies & hard copies) shall be given to the Engineer.

EPLC 16 CSCI (COMPUTER SOFTWARE CONFIGURATION ITEMS)

High-level plant "classes" identified during the analysis phase shall be mapped to CSCI (Computer Software Configuration Items). Child classes shall be mapped to CSC (Computer Software Components) and CSU (Computer Software Units), in accordance with the class hierarchy of the system.

Each CSCI shall be comprehensively documented in a SRS (Software Requirements Specification).

A CSCI, CSC and CSU shall be characterized by one or more control function instances. These instances may be grouped into one or more control function types. Control function types include interlocks, trips, control algorithms and other functional and logical entities that are required for interaction with and control of a specific piece of plant equipment.

EPLC 17 SRS (SOFTWARE REQUIREMENTS SPECIFICATIONS)

Each CSCI must be specified by means of a SRS. The SRS shall meet the following minimum requirements:

Each plant component that has been subjected to object-oriented analysis shall be described by a set of overview class hierarchy diagrams that illustrates the inheritance relationships that are inherent in the system. The class hierarchy diagrams shall illustrate inheritance in:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- The PLC Input & Output points
- Discrete and batch control functions, e.g. interlocks, trips, start-up sequences
- Continuous process control functions, e.g. PID (Proportional - Integral - Derivative) Control
- The analog and digital values that are generated by the PLC software and/or communicated to the SCADA system, e.g. metering information

The SRS shall contain an introductory subsection that describes the purpose of the software system, and in particular, the role of the PLC software in the system.

The SRS shall specify the names and descriptions of all analog and digital plant inputs and outputs that are communicated to or from the PLC.

The SRS shall incorporate several subsections called Control Function Sections (CFS), each describing a number of instances of a specific control function. For example, a PLC program may implement several PID control loops. The software segment specification would then incorporate a "PID Control Loops" section, in which each PID control loop is described in detail, in keeping with a standard layout.

The SRS shall list and describe all digital or analog values that are generated by the PLC software (or that are scanned into the PLC) and then transmitted to the SCADA system.

The SRS shall include a detailed explanation of how the PLC driven systems operate in conjunction with the hard-wired systems.

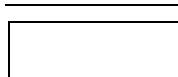
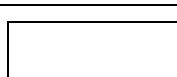
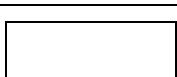
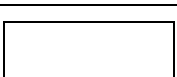
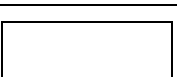
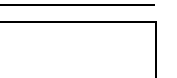
EPLC 18 GENERIC LAYOUT

Each CFS shall conform to the following generic layout:

- Control Function (CF) type and instance number - this number shall be unique for each instance in a control function class hierarchy

Name	- A short text label that describes the control function.
Description	- Textual explanation of the behavior of the control function.
Software	- Explanation of the PLC logic that is used to implement the control function.
Algorithm	- The names of all the PLC inputs and outputs that are used shall be given in the algorithm description

- SCADA indication - the SCADA indication details of the CF (Control Function) are given, including the location of the indicator, the colour of the indicator, and the message details.
- Notes and associated conditions - any settings that may be relevant to the CF, or any conditions such as alarms or pre-conditions that relate to the CF shall be documented.
- For example, the requirements section may incorporate a subsection describing the interlocks that pertain to the particular class. Each interlock description shall incorporate the following:

					
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- | | |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interlock number | - This number shall be unique for each interlock in a class hierarchy |
| Name | - A short text label that is normally the same as the interlock message |
| Description | - Textual explanation of the function of the interlock |
| Software Algorithm | - Explanation of the PLC logic that is used to implement the interlock. The names of all the PLC inputs and outputs that are used shall be given in the algorithm description. |
| SCADA indication | - The SCADA indication details of the interlock are given, including the location of the indicator, the colour of the indicator, and the message details. |
| Pre-conditions | - These are any pre-conditions that must be satisfied before it can be confirmed that the interlock is unhealthy. In some cases it may be necessary to explain the algorithm and PLC logic of the pre-conditions and any overrides that may be present. |

EPLC 19 NAMING AND DOCUMENTATION OF SOFTWARE

Each PLC program shall be documented in a manner that allows the reader to understand the functionality of the program, and to locate the desired section of ladder logic.

A short "Program description" document shall be produced for each PLC program. The primary functions of the program shall be listed in this document. For example, the program might monitor and control electricity reticulation, provide water quality monitoring functions, and allow for the control of certain pump sets.

Each PLC program shall consist of several segments. Segments are used to divide the program in to logical sections. Segments are the basic schedulable entities within the PLC software. Each segment shall be documented by means of an SFC list. The SFC list gives some indication as to the purpose and structure of the program. Segment comments may be up to one page in length.

PLC segments consist of several SFCs. Each SFC shall be documented by means of a list of networks within the SFC. The list shall identify which of these networks are implemented as macros and which are specific and unique to the SFC. This list is intended to give some indication as to the purpose and structure of the SFC. SFC comments may be up to one page in length.

Each SFC consists of a number of networks. The logic employed in each network shall be described in the network comments that may be up to one page in length. Where a network is implemented by a macro, the macro comments may be copied to the network comments screen, or the network comments screen may simply reference the macro comments. Macro comments and network comments shall describe the PLC logic in terms of "power flow" that is regulated by the opening and closing of coils.

Each coil and register that is used in the PLC program shall be described in the comments field that may be 50 characters long (10+10+10+20).

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Print outs of appropriate ladder logic shall be attached to all network comment documents.

EPLC 20 MACROS

Macros shall be used wherever possible in the implementation of PLC software in order to promote software re-use.

Common software elements shall be identified from the plant class hierarchy.

A set of macros shall be associated with a specific plant class hierarchy, although a direct mapping of macros to entities in the hierarchy may not result in optimal re-usability. In such instances, the macros shall rather be designed for optimal re-usability.

The PLC logic used in macros shall be described in the macro comments screen.

The design of macros shall not be explicitly documented. The software segment specification relating to each software segment identified in the plant class hierarchy shall describe the functional and behavioural aspects of the PLC software. If the software has been implemented in terms of macros, then the reader shall know this from the network comments that are associated with the relevant software.

EPLC 21 OPERATIONS MANUAL

An "Operations Manual" shall be delivered with the software. This manual shall contain the following information:

- Details of all instruments and devices that shall be connected to the PLC
- Details of PLC - network connections.
- A user document that describes how the PLC program shall operate in conjunction with new/existing SCADA systems, hard-wired systems and mimic panels
- This document shall inform the user of alternative control options, and give some idea of how the PLC system integrates with the plant and its hard-wired systems.

EPLC 22 TEST SPECIFICATION

A test plan shall be developed for each software segment whilst the software segment specification is being drawn up.

The test plan shall focus initially on verifying the architectural design of the program that is that the partitioning into segments, SFCs and networks has been performed in an intuitive and logical manner.

Each trip, interlock and data output shall be tested by varying all pre-conditions and overrides. The test scenario for each case shall be comprehensively described. Details of how to model a particular override or pre-condition by modifying the hard-wired configuration shall be given.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Explicit criteria shall be given in terms of which the interlock or trip shall be deemed to have passed or failed the test.

EPLC 23 WALK-THROUGHS

Structured walk-throughs and code inspections shall be carried out during the development of each software segment.

Walk-throughs shall initially focus on verifying the architectural design of the program that is that the partitioning into segments, SFCs and networks has been performed in an intuitive and logical manner.

Ladder logic networks shall be tested individually. All possible coil status permutations shall be identified for each network. Factors that may cause coil statuses to change shall be identified and the ramifications of changing coil statuses shall be investigated. Where registers are used in the networks, factors affecting register values shall be identified, and tests shall be devised to investigate the behaviour of the software when register values change to and from critical values.

A checklist shall be used to allow PLC programs to be checked for common PLC programming faults. The checklist shall be maintained on an on-going basis to ensure that the maximum number of common errors can be detected before testing and commissioning.

EPLC 24 TEST PROCEDURE

Software testing shall be carried out on site.

Before testing begins, the plant to be used in the on-site tests shall be de-commissioned and configured for testing.

Trips, interlocks and data outputs shall be tested individually. These tests shall follow the test specification that was produced in parallel with the software segment specification.

A test compliance document shall be completed during the test phase, and this document shall be included in the project documentation.

EPLC 25 CHANGE MANAGEMENT

Changes to the functionality of a program may be required if the system fails due to an identifiable fault in the program, if the requirements change such that the change in specification forces a change in the software, or if sub-optimal system behaviour can be improved through software modification.

Faults reports shall be generated by the plant operators, and they shall be passed on to the software configuration manager. Similarly, any change in requirements that leads to a change in specification shall be passed on to the software configuration manager.

Changes shall first be made to the software requirements specification. The ramifications of making the changes shall be investigated, and the software modules (segments, SFCs, networks) that are affected shall be identified and modified.

Before the software changes are effected, a test plan shall be produced that describes how the changes are to be approved. This test plan shall be incorporated in the project documentation in the "Change control" section.

A walk-through inspection shall be held once the changes are complete. The primary goal of this inspection shall be to determine that all possible side effects that may be produced by the changes have been anticipated and explicitly dealt with.

Minutes from this inspection shall be appended to the body of the main project documentation in the "Change control" section.

The modified software shall then be tested according to the test procedure that was produced when the specification was amended.

EPLC 26 MEASUREMENTS AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below.

EPLC 26.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For programmable logic controller's, design information shall include, but limited to as listed in this Particular Specifications. A Control System integrator/specialist shall be required to complete this design and engineering tasks and the contractor shall allow adequate time for the complete design and engineering of the PLC Control System.

<u>Pay Item</u>	<u>Unit</u>
(a) The Contractor will provide the following design calculations, Drawings and wiring diagrams for approval by the Engineer: <div><div>a) Fibre loss design calculations in excel format which will include but limited to From, To, Distance losses and Tag numbers and total losses through the fibre network [fibre losses]</div><div>b) Electrical Load lists in excel format of all PLC equipment.</div><div>c) Engineer design drawings of network layout which contains all IP addresses, equipment and drawings.</div><div>d) Report which will include antennae radio paths, drawings which have line of sight of all locations in AutoCad Format, Connection speeds with the radio or wireless communication, details of all Radio & Wireless Radio losses</div></div>	Sum

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- e) Input and Output schedules in excel format which contains all tag numbers, names, commands, and description of all I/O
 - f) Loop diagrams in AutoCAD format
 - g) Cable schedules in excel format which will include but limited to From, To, Distance and Tag numbers
 - h) AutoCAD drawing of all equipment positions, equipment layouts, cable layouts, rack layouts, router / modems, switches connections and layouts.
 - i) P&ID drawings of the entire system which is implemented and equipment in AutoCAD format which shall strictly accordance to ANSI/ISA-5.1 [American national Standard]
 - j) Functional design specification which will include but not limited to all mimic diagrams, control procedures compared to control philosophy and a detail description how the PLC will control the entire system [broken down into each component].
- (b) Provide operating and maintenance manuals, data sheets of all equipment and “as built” drawings Sum

EPLC 26.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For Programmable Logic Controllers System, the rate tendered shall be for the complete Programmable Logic Controllers System and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery of a complete PLC and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b) Supply and delivery of a complete UPS as specified	Each
(c) Supply and delivery of a complete HMI as specified	Each

EPLC 26.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of Programmable Logic Controllers system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the PLC system complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

standards and applicable portions of "Standard of Installation", for installation of Programmable Logic Controller System but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of a complete PLC and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b) Site installation of a complete UPS as specified	Each
(c) Site installation of a complete HMI as specified	Each
(d) Site cable connections and programming of all PLC Systems	Sum

EPLC 26.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of a complete PLC system and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b) Commissioning of a complete UPS as specified	Each
(c) Commissioning of a complete PLC System HMI as specified	Each
(d) Commissioning of a PLC system programming and operation of plant in automatic and manual mode	Sum

END OF SECTION

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25


**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

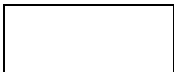
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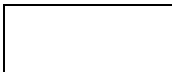
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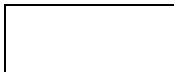
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Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

ESCA SCADA - SUPERVISORY CONTROL AND DATA ACQUISITION

As specified in the Project Specifications.

ESCA 1 ABBREVIATIONS

SCADA	-	Supervisory Control And Data Acquisition
ECI	-	External network – control network Interconnection
IRA	-	Interactive Remote Access to a control network
ICC	-	Inter-Control Centre access to a shared control net
CNH	-	Control Network Host
AFD	-	Automation Field Host
FCN	-	Field Control Network within single control area
CCN	-	Control Centre Networks within single control area
SED	-	Standalone Embedded Device
ACI	-	Inter-Area Communication within hierarchical multi-area control network

ESCA 2 STANDARDS

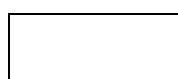
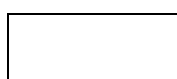
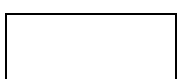
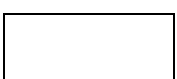
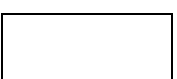
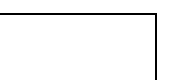
The SCADA shall conform to and be in accordance with the latest applicable IEC, ISO, and IEEE Standards:

The following Standard Specifications and drawings shall apply:

Standard No.	Description
SCADA	Supervisory Control And Data Acquisition
ECI	External network – control network Interconnection
IRA	Interactive Remote Access to a control network
ICC	Inter-Control Centre access to a shared control net
CNH	Control Network Host
AFD	Automation Field Host
FCN	Field Control Network within single control area
CCN	Control Centre Networks within single control area
SED	Standalone Embedded Device
ACI	Inter-Area Communication within hierarchical multi-area control network

ESCA 3 HARDWARE CONFIGURATION

The SCADA system shall consist of multiple servers, work stations, engineering stations, Historian, off-site disaster recovery sites and software responsible for communicating with field equipment like PLC's, RTU's and smart sensors. Where required, the SCADA system shall comprise only of a master station for instances where the installation is small. Instances where dual-redundant or hot-standby formation SCADA systems are required, redundant servers, dual networks and redundant switches shall be installed for increased reliability.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESCA 4 ALARMS

The effective management of all alarm signals received on the SCADA system is required to ensure the effective management of plant and equipment. The alarm management is required to prevent the following scenarios:

- a) Alarm flooding leading to the overwhelming of the operator's cognitive abilities.
- b) Alarming of insignificant criteria leading to unnecessary actions by the operator's.

The flooding of alarms with any proper form of alarm management shall lead to distractions on the part of the operator's, thus decreasing vigilance in the long run. The alarm management system shall provide all the requirements needed to ensure an efficient and stringent alarm management system.

Some of the alarm management capabilities shall include the following:

- a) Alarm grouping
- b) Alarm filtering
- c) Alarm inhibiting
- d) Alarm shelving
- e) Alarm suppressing

The alarm management system shall be able to do statistical analysis on alarms and also provide advanced alarm reporting. The system management of alarms shall be categorized according to groups and certain priorities.

These shall be assigned according to a hierarchical structure depicting priority importance (normally from top to bottom, with the top alarm having the highest priority).

ESCA 5 SCADA PROTOCOLS

Any previous legacy SCADA protocols proposed shall be ModBus RTU, ModBus TCP, Profibus and Profinet. However, the more recent and more secure SCADA protocols shall conform to the IEC 60870 Part 5 Standard. These are defined under the following sections:

- a) IEC 60870-5-1 sTransmission Frame Formats
- b) IEC 60870-5-2 Data Link Transmission Services
- c) IEC 60870-5-3 General Structure of Application Data
- d) IEC 60870-5-4 Definition and Coding of Information Elements
- e) IEC 60870-5-5 Basic Application Functions
- f) IEC 60870-5-6 Guidelines for conformance testing for the IEC 60870-5 companion standards
- g) IEC 60870-5-101 Transmission Protocols, companion standards especially for basic tele control tasks
- h) IEC 60870-5-102 Companion standard for the transmission of integrated totals in electric

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

power systems

- i) IEC 60870-5-103 Transmission Protocols, Companion standard for the informative interface of protection equipment
- j) IEC 60870-5-104 Transmission Protocols, Network access for IEC 60870-5-101 using standard transport profiles

The other approved SCADA Standard protocols shall be IEC 61850 and DNP3. The contractor shall confirm with the Engineer the list of proposed protocols they intend using, if different. The Engineer reserves the right to refuse certain protocols that do not comply with the requirements.

ESCA 6 DESIGN PHILOSOPHY

The SCADA system shall be designed to withstand temperature fluctuations, vibrations, and voltage fluctuations. Redundancy, where required shall be incorporated through redundant hardware and redundant communication paths. The contractor shall give through a proposal on how they intend achieving redundancy, if required on the SCADA system. The Engineer shall approve the proposal before the contractor can implement the design.

ESCA 7 SECURITY

SCADA systems shall be designed to be open, robust, and easily operated and repaired. The SCADA system shall however be designed utilizing the latest in security enhancements and features, thus ensuring data protection, integrity and privacy.

Any vendor, whose SCADA packages have been under recent attacks within the last 12 months, shall provide proof of the total eradication of any malware, worm and viruses infected in their subsequent software packages, wherever they were installed.

Furthermore, the specific vendor shall provide a root cause analysis why the infection/attacks were able to manifest itself in their software and what measures were taken to eradicate the infections.

The vendor shall also prove the commitment from their company to prevent further malware attacks on their software in the future by outlining their global security implementation strategy.

Failure to provide these requirements to the Engineer shall void their SCADA package from the selection process. The SCADA vendor shall ensure that the below mentioned security issues are encompassed and dealt with effectively in their SCADA packages.

The main reasons why security issues arise are the following:

- a) The general lack of concern about implementing security and authentication when doing the design, during installation and during operation of the SCADA networks. The contractor shall ensure all required security measures have been put in place during the design, installation and operation of the SCADA system, including the use of advanced encryption

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

standards.

- b) The incorrect belief that SCADA systems have the required security by simply using specialized protocols and proprietary interfaces. The contractor shall ensure all required security measures has been implemented when interfacing to existing or legacy systems and third-party equipment.
- c) The incorrect belief that SCADA networks are secure just because they have been physically secured.
- d) The incorrect belief that SCADA networks are secure just because they have been disconnected from the Internet. The contractor shall ensure that where access to the SCADA system is required via a router, that stringent IT policy implementation has been effected over the entire OSI model, including the physical, data link and network layers.

SCADA systems face many threats to their data integrity and security. Some of the main security threats are the following:

- a) The unauthorized access to the control software through human access. This is when changes are done either intentionally or accidentally by virus infections and other software threats residing on the control host machine. The contractor shall ensure the risk unauthorized access is diminished by selecting a SCADA system that has lines of specialized industrial firewalls and VPN solutions for TCP/IP-based SCADA networks. The contractor shall further ensure that the hardware supplied have all their I/O ports blocked from people accessing the equipment using USB sticks, SD cards, CD's or DVD's.
- b) The unauthorized access to the control software through packet access to the network segments hosting SCADA devices. This can be through physical access to SCADA-related network jacks and switches. The contractor shall ensure IT security policies are implemented on all levels of the OSI model.

ESCA 8 GENERAL REQUIREMENTS

The SCADA system shall utilize client/server technology to support multiple users operating in a networked environment. A configuration server shall be required for managing and saving the configuration information.

The configuration server shall be able to support multiple simultaneous client connections, whilst providing users with shared access to a system's configuration information and real-time plant data. A communication server shall also be provided.

The configuration server shall store the data in a single database per each system. The storing of duplicated data shall not be allowed. Only common file formats that are widely used and accepted in the industry shall be accepted.

The system shall be so designed that all engineering tasks are not done in the runtime environment. This is to ensure very little process interruption.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The SCADA system shall have tools for seamless integration. The SCADA system shall have very good workflow automation and be able to do bulk import and export functions.

The SCADA system shall have a comprehensive range of engineering tools that can do easy configuration of control systems. The SCADA system shall consist of system libraries consisting of reusable software components.

The SCADA system shall be able to configure user information for the Windows and Engineering databases. It shall further allow for creation of user profiles along with their roles and certain project access permissions.

ESCA 9 PROJECT ADMINISTRATION

The SCADA system shall be able to manage the inflow and outflow of information by multiple users on automation projects.

The SCADA system shall allow certain designated individual with project administration privileges to perform various activities including but not limited to user assignments to projects, offline and online back-up of projects, project database maintenance and upgrade of projects from previous versions

The SCADA system shall allow a multi-user engineering environment providing high flexibility and efficiency for system configuration, documentation, commissioning and maintenance tasks.

Note - The SCADA system shall provide an Audit trail to enable effective management of changes. All changes to information within the automation system shall be carefully controlled to ensure all modifications are traceable and accountable.

The audit trail shall consist of any user actions which include system changes made at any engineering workstation onto a central database. These events shall be recorded onto an Historian for future audit purposes.

Users, with the applicable project administration privileges shall be capable of performing the following activities:

- Creation of System design projects
- Offline and online back-up of projects
- Project database maintenance

Upgrade of projects from previous versions

A multi-user accessible engineering platform shall be provided to attain a high level of flexibility and efficiency when doing system configuration, documentation, commissioning and maintenance. Engineering tasks shall be accessible by multiple users at any given time.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The option shall be available for an Engineer/s to reserve a complete application or some part of it for their exclusive access. This shall enable multiple users to be able to work on the same project at the same time without interfering with each other's work.

The SCADA system shall have an effective audit trail to provide effective change management. Changes within the automation system configuration shall be carefully controlled via the audit trail to ensure all modifications are traceable and accountable.

The audit trail functions shall include the tracking of user's actions, the archiving of user actions including any system changes made at any engineering workstation onto a central database. The SCADA shall have graphical user interfaces, object-related context menus, navigation windows, help functionality and a host of other features to provide sufficient guidance to the user.

Within the engineering environment, users shall be able to navigate from a specific tag to its associated control logic diagrams/P&ID/Loop Diagram. Links to 3rd party documentation like PDF user manuals, excel reports, etc. shall also be possible.

The engineering builder tool shall allow users to build projects through a simple drag and drop application. The engineering builder tool shall make the drawing of any logical and detailed network architecture easy. It shall allow for the easy configuration of communication ports.

The engineering builder tool shall be able to do the following:

- Design and draw logical and detailed network architectures
- Do the automatic configuration of the communication ports of a project
- Publish network addresses to all reachable PC nodes
- Have access to updated design information available for the updating of the main project design
- Provide easy generation of reports and any documentation required

The SCADA system shall have a central data base for all tag information. There shall not be any replication of changes in multiple databases. The SCADA system shall allow for easy database filtering via a user friendly menu for easier and faster configuration work.

The SCADA system should be so designed to allow Engineers to be able to import and export any amount of tag data, perform automatic searches and replace operations using any type of complex query commands. The SCADA system shall allow users to navigate directly from any tag to its related configuration document.

The SCADA system shall have the functionality to save multiple macros for future use. The SCADA system shall also have a standard library wherein function blocks (objects) can be used by simple "drag and drop" functionality for projects.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The standard library shall contain components, general layouts, loop diagrams, hook-up layouts, devices, P&I diagrams, equipment & instrumentation symbols, operation and control processing function blocks, I/O configuration, I/O lists, coding and any dimensions, etc.

The library shall also have the functionality of saving any macros, symbols, shapes, control logic templates, etc. that have been designed on previous projects.

The standard library shall also have the functionality of allowing the regular updating to this library of new function blocks, macros and code. This shall be at no extra cost to the SCADA system, but as a “self-learning” function of the library.

The SCADA system shall have standard Control Logic Templates, thus allowing for the reduction in time and costs normally associated with the implementation of a control project. The SCADA system shall allow for the functionality of designing, editing or maintaining Control Logic Templates.

The SCADA system shall have the functionality of handling large amounts of data by being able to:

Allow the import of process points and/or I/O spread sheets from which configuration can be done

- Allow the import of signal lists and their properties
- Allow the control of hardware
- Allow the assignment of I/O and the instantiation of I/O templates
- Allow the instantiation of Control Logic Templates

The SCADA system shall allow for the automatic updating to of all the above mentioned lists, using a central engineering database. SCADA systems that require the re-importing of revisions to the lists mentioned above for any changes made shall not be considered.

The SCADA system shall have the functionality of mapping. Furthermore the mapping shall be saveable for future work. The SCADA system shall have the further functionality of importing specific I/O signals for specific tasks like during the testing and commissioning phases of a project, thus not affecting the main engineering database.

The SCADA system shall have the functionality of fully supporting the configuration, testing, commissioning, maintenance and management of intelligent field and electrical devices like flow transmitters, pressure transmitters, temperature transmitters, level transmitters, turbidity transmitters, pH transmitters, analytical transmitters, actuators, motor control centres, etc. by using Profibus, ModBus, Ethernet TCP/IP, Hart, etc. communication protocols.

The SCADA system shall have the engineering tools required for the configuration and management of intelligent devices in a graphical environment. Additional tools shall include a batch data manager for the creation, editing, managing, downloading and debugging of function code, whether batch, user-defined or in sequential configuration.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESCA 10 SCADA HARDWARE CONFIGURATION

The server setup for the SCADA system shall encompass front and back end server/s arrangements. When clients request information (via the client access portal) to a specific folder, the front end server/s shall check the Active Directory to find a list of all the back end server/s having the information the client is searching for.

The setup for the front end and back end server/s topology shall ensure the following:

- a) The Client access to requested information/folders is done on the front end server/s.
- b) The front end server shall authenticate the user on an active directory.
- c) The front end server shall determine firstly (without any client intervention required), in which location/folder the requested information resides and secondly on which back end server (if there are more than one back end server/s) the requested information is residing.
- d) The front end server shall "learn" from each previously processed request for information, so that instead of searching the entire data base again for previously requested information, the front end server/s can go directly to the correct data base holding the required information, thus minimizing search time.
- e) An algorithm shall manage the search for information on the back end server/s, whilst balancing the work load to each back end server/s.
- f) If one of the back end servers is off-line, the algorithm shall divert the search request to another/other back-end server/s that also has the exact same information.
- g) The algorithm shall divert all requests for information towards the remaining available back end server/s equally, thereby ensuring correct load balancing.
- h) Whenever a back end server is again on-line, the algorithm shall redistribute the traffic flow evenly (load balancing) over all the available back end server/s (those holding the requested files).

The algorithm shall also regulate the workflow such that one particular back end server is not "overworked", whilst another is hardly ever accessed.

Note: Project administrators shall inform all users if any folders/files have been removed from the back end server/s.

Dual authentication shall be required on both the front end and back end server/s.

Between the Client station and front end server, authentication is required. Authentication shall also be required between the front end and back end server/s. Basic authentication and forms-based authentication shall be acceptable, provided the contractor has reviewed the hardware/software firewall requirements

Basic authentication shall encompass the requirements for a user name and password of the user requesting folder/file access to the server, via a client access terminal. This shall be done in the following format: domain\username.

When using forms-based authentication, SSL encryption shall be required between the client access and front end server/s as well, especially where the front end server/s and back end

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

server/s have separate subnets or use external networks. SSL shall protect user passwords from any network packet sniffing software.

Note: SSL shall be always configured on the front end server only in a front end/back end server configuration. For situations where there are only back-end servers (no front end/back end server configuration) and clients are directly accessing them, SSL configuration shall be a requirement

If there is a considerable decrease in performance due to SSL connections, a SSL accelerator shall be required to the front end and back end topology.

The type of SSL accelerator selected shall depend on the number of front end servers in your topology. If the quantities of front end servers are minimal, then the option of using SSL accelerator cards shall be acceptable due to its lower cost, effectivity to handle SSL tasks and simple installation.

For each accelerator card required, the SSL certificate of each accelerator card requires configuration and there are administrative costs as well.

If the quantities of front end servers are many, then a separate SSL accelerator device shall be required. The setup in this case shall be simpler as it only requires configuring once, no matter how many front end servers are in your setup.

Internet Protocol Security (IPSec) shall be a requirement for all communication between the front end and back end server/s setup.

The type of IPSec protocols allowed shall be Authentication Header (AH) and Encapsulating Security Payload (ESP). IP Packets of information that uses AH are not encrypted, but work by adding a checksum to the IP packet. If the checksum is identical between what was sent and what was received, then the message was delivered successfully.

ESP on the other hand works by encrypting the entire contents of the IP packet. The encryption affects the performance on both the front and back end servers, Therefore, the design to the front and back end topologies shall take due cognizance of any degradation to performance when implementing either ESP or AH.

The perimeter network shall have a firewall server between the front end and back end servers. The firewall server shall have the latest service packs and have extremely stringent security methodologies.

The front-end server/s shall have sufficient memory and very fast CPU clock speeds. The recommended ratio of front end server to back end servers shall be 1:3. The contractor shall indicate any reasons for diverting from this ratio.

Software and/or hardware firewall solutions shall be required. The various methods of firewalls shall be through the use of port filtering, IP filtering and application filtering.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Port filtering shall be the absolute minimum Firewall requirement. Port filtering shall be used to restrict network traffic coming through the firewall and allow access to information sent via specific ports only.

IP filtering shall also be required as a Firewall requirement. This shall restrict traffic through the firewall to specific servers only.

Application Filtering shall also be used as well as a firewall to provide advanced inspection at the application protocol level. This type of firewall shall perform functions such as the filtering of Remote Procedure Call (RPC) interfaces and the validating of any HTTP request syntax applications.

ESCA 11 HISTORIAN

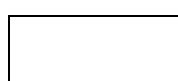
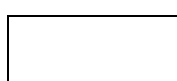
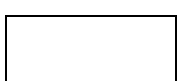
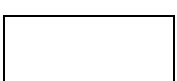
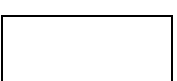
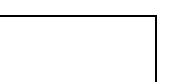
The function of the Historian shall be to analyse and display information in a usable, understandable and meaningful manner so that real-time business decisions can be made.

The requirements of the Historian server shall be as follows:

- a) The Historian package shall be complete and already pre-configured. No additional engineering shall be allowed or required.
- b) The Historian package shall be able to provide detailed statistical reports for any and every desired time frame.
- c) The resolution shall be of a very high quality.
- d) Historical data from all the plant equipment shall be seamlessly integrated
- e) Data collection shall be event based and in real time with millisecond resolution.
- f) Memory and storage requirements shall be well managed when accessing historical data
- g) Statistical reports and Trend displays shall be generated on demand and within one second.
- h) The Historian package shall have unlimited historical data collection
- i) The Historical data reports shall be according to the following requirements:
 - i. Shall have access to all historical information and real-time data quickly and efficiently
 - ii. Shall have a clearly arranged event historical display with integrated trend data graphics package
 - iii. Shall enable complex graphics to be read and understood easily
 - iv. Shall enable Report configuration to be done easily by utilizing simple drag and drop interfaces
 - v. Shall have OPC server and client to enable easy data exchange with foreign systems
 - vi. Shall have life cycle management services available

ESCA 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESCA 12.1 Supply and Delivery to Site

<u>Pay Item</u>	<u>Unit</u>
a) Supply and delivery to site of SCADA system associated hardware, installed as per design requirements and best practice, all as specified.	Sum
b) Supply and delivery to site of SCADA system associated software, installed as per design requirements and best practice, all as specified.	
c) Supply and delivery to site of SCADA UPS	Sum

ESCA 12.2 Installation

<u>Pay Item</u>	<u>Unit</u>
a) Installation of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
b) Engineering and configuration of SCADA system associated hardware and software.	Sum
c) Installation of SCADA UPS	Sum

ESCA 12.3 Commissioning

<u>Pay Item</u>	<u>Unit</u>
a) Commissioning of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
b) Commissioning of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
c) Commissioning of engineering and configuration of SCADA system associated hardware and software.	Sum
d) Commissioning of SCADA UPS	

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

ECIS CONTROL AND INSTRUMENTATION SYSTEMS

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ECIS CONTROL AND INSTRUMENTATION SYSTEMS

ECIS 1 SCOPE OF WORKS

As specified in the Project Specifications.

ECIS 2 PRESSURE TRANSMITTERS

The pressure transmitters shall be pipe socket mounted and shall constantly display the relevant pressure and shall be easy to calibrate and reliable in service.

The pressure sensor shall have a ceramic diaphragm with electrodes in the ceramic substrate and diaphragm. A pressure proportional change in the capacitance shall be measured by the electrodes and displayed as the measuring pressure value.

The pressure sensor shall comply with the following technical requirements

Application	-	Measuring of absolute and gauge pressure in liquids
Measuring technique	-	Deflection of diaphragm
Measuring range	-	As specified in Variations and Additions to General and Particular Specifications
Construction	-	304 Stainless Steel housing
Mounting	-	½" pipe socket mounted
Pressure		16 bar or as required for application
Voltage	—	0 – 30VDC
Output	-	4 – 20mA
Accuracy	-	+/_ 0.2%
Reproducibility	-	+/_ 0,3%
Long term drift	-	+/_ 0,1% per year
Protection	-	IP 68
Display	-	Plug in display unit

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Sensor cable - Screened transposed two-wire cabling

ECIS 3 FLOW METER EQUIPMENT

Flow meters will be supplied and installed by the mechanical contractor if not otherwise indicated. The flow meter controllers as free issue items will have to be installed under this contract in flow meter kiosks complete with a supply of electricity, surge protection and earthing system.

ECIS 4 ELECTRONIC LEVEL CONTROL

The micro based electronic controllers which will be mounted in the motor control centres or as specified and shall be easy to calibrate and reliable in service.

The transducers shall be designed to operate in air, been capsulated, of rugged construction and impervious to submergence.

The transducers shall, where possible, be installed at a point 500mm away from a wall or pipe, which may cause a false signal, and at least 500mm above maximum water level.

The coaxial cable between the transducer and power unit shall be of sufficient length to avoid any joints in this cable, as no joints will be permissible.

The grade 304 stainless steel brackets for mounting of level transducer must be provided and installed under this contract.

ECIS 5 NO-FLOW SWITCHES

The electromagnetic flow monitor shall be pipe socket mounted and shall be easy to calibrate for specific no-flow conditions and shall be reliable in service.

The no-flow sensor shall be steel pipe mounted and shall be supplied complete with a weld stub to ensure correct immersion into the measuring liquid. The weld stub shall be adapted according to the flow measuring pipe diameter.

The no-flow sensor shall comply with the following technical requirements:

- | | | |
|---------------------|---|----------------------------------------------------------------------------------------------------------------------------|
| Application | - | Measuring of no-flow condition in water pipe lines for pump set protection |
| Measuring technique | - | The flow sensor shall adopted the electro-magnetic principle of flow velocity measurement at the tip of the no-flow sensor |
| Measuring range | - | As specified in Variations and Additions to General and Particular Specifications |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Construction	- Die-cast aluminium housing, epoxy coated
Mounting	- Weld stub mounted
Voltage	— 0 – 30VDC
Output	- 4 – 20mA
Accuracy	- +/- 2%
Reproducibility	- +/- 2%
Conductivity	- $\geq 20\mu\text{S/cm}$
Protection	- IP 66 / NEMA 4X / Type 4X
Settings	- Potentiometer adjustment

ECIS 6 FREE CHLORINE ANALYZER

The free chlorine analyser shall be an enclosed unit with front door mounted free chlorine content display unit with storage space for reagent. The unit shall be wall mountable.

The analyser shall sample every 2,5 minutes and shall use less than 475mL each of indicator and buffer over a 30 day period. A linear peristaltic pump, seal-free mixer, easy-to-clean cell and compact colorimeter shall provide a reliable low maintenance operation.

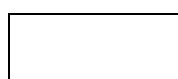
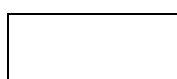
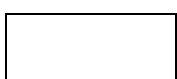
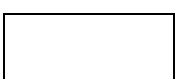
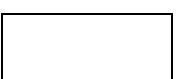
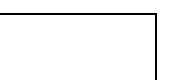
The analyser shall be equipped with a programmable 4-20mA recorder output and two user selectable alarms and shall be installed on a 230 Volt supply system.

The mixing system shall operate with no moving parts and a self-cleaning stir bar in the sample chamber shall generate a vigorous mixing action for accurate sample analysis. A transparent gasket shall occupy the space between the light source, sample chamber and detector. The optically clear RTV silicon light pipes shall transmit the colorimetric beam and minimize the risk of interference caused by high levels of humidity.

The measuring range shall be 0 to 5 mg/L free or residual chlorine.

Accuracy shall be +/- 5% or +/- 0.035mg/L, whichever is the greater.

The analyser shall be supplied with a three months' supply of reagent

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ECIS 7 PH SENSOR

The ph sensor shall be of the pipe insertion mounted type with an LCP body glass electrode and titanium ground rod.

The instrument shall have a pH measuring range of 0 – 14 and temperature range of -5 to 95°C. The sensor shall be rated to withstand a pressure of 6 bar.

The sensor shall have a sensitivity of less than 0.005pH and shall have three measuring electrodes, a standard and process electrode as well as a ground electrode. If necessary, a digital gateway shall be provided with the pH sensor for communication with the same controller as the turbidity sensor.

ECIS 8 TURBIDITY SENSOR FOR LOW TO MEDIUM RANGE TURBIDITY MEASUREMENTS

ECIS 8.1 Turbidity sensor

The Turbidity sensor shall have a pulsed infrared source in conjunction with an automatic cleaning process and shall be a precision bypass sensor suitable for ultra-clear media to media with medium turbidity due to the particular low level of light interference.

The sensor enclosure shall have an IP 65 rating and shall be separately mountable from the controller up to a distance of 50m. Sensor to controller connection cable shall be provided with the sensor unit. The sensor shall be reconcilable with the existing turbidity and pH controllers installed on the plant.

The turbidity sensor shall comply with the following technical specifications:

Measuring technique	- 90° scattered infrared light in accordance with DIN EN ISO 7027
Measuring range	- 0.0001 – 1000 NTU
Precision	- +/- 1%
Reproducibility	- +/- 0,5%
Air bubble compensation	- Physical-mathematical
Sample size required	- Min. 0,2l/min, max. 1l/min. max. 6 bar
Ambient temperature	- Max. 40° C
Automatic cleaning	- Wiper cleaning

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



- | | |
|--------------|------------------------------------------------------------------------------------------------------------------------------|
| Materials | - Quartz measuring window, silicone wiper profile, Noryl GFN2 measuring chamber, ASA housing and stainless steel wiper axle. |
| Sensor cable | - +/- 5m length |

ECIS 8.2 Turbidity controllers

The turbidity controller shall be a product from the same manufacturer as the turbidity sensor and shall be capable of receiving data from two sensor units and shall communicate with a PLC by means of RS485/MODBUS protocol. The controller shall be microprocessor-based and housed in a ½ DIN, NEMA 4X enclosure with an IP rating of IP66.

Multiple control functions shall include built-in PID, control contacts and alarm functions.

The turbidity sensor shall comply with the following technical specifications:

- | | |
|--------------------|---------------------------------------------------------------------------------|
| Ambient conditions | - -20°C to 40°C, 0 – 95% relative humidity and non-condensing |
| Power requirements | - 230V AC |
| Display | - Graphic dot matrix LCD, 128 x 64 pixels with LED backlighting |
| Relays | - Three SPDT user configurable contacts rated 230V AC 5Amp. |
| Outputs | - Two analog 4-20mA |
| Control | - PID, high/low phasing, set point, dead band, overfeed timer, off and on delay |
| Communication | - RS485 MODBUS |
| Memory | - Non-volatile setting memory |
| Mounting | - Wall mounting |
| Certifications | - ETL to UL 6101A-1 and CSA C22.2 No. 1010.1 |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ECIS 9 ROTATING BRIDGE BRUSH GEAR

The brush gear to be installed on the kingpost on the bridge at the centre of the tank to facilitate connections between the incoming supply cable and the cable from the kingpost to the motor starter via the rotating arm shall consist of the following:

- A set of four 20 mm wide and three 8 mm wide brass slip rings on an ebonite or equivalent insulating sleeve (i.e. three slip rings or phase connections, one for the earth connection, three slip rings for the control circuit, namely, start, common and stop connections). Connections to these slip rings shall be affected via an approved heavy duty terminal block with stud type brass terminals onto which the lugs on the cable tails shall be bolted. This terminal arrangement shall be completely independent of fixing screws for the slip rings.
- A set of four main circuits and three control circuit "Morganite" carbon brushes, or equivalent. Each of these brushes shall be spring-loaded to ensure high contact pressure and the springs shall be rust-proofed.

The abovementioned brush gear shall be installed in a weatherproof IP55 grade UV protected and impact proof synthetic housing with removable cover, on the kingpost of the bridge. This brush gear-housing shall be suitably sized to accommodate the relevant equipment without cramping, and shall be insect proofed.

The brush gear housing shall be designed and constructed to prevent the accumulation of gas and the condensation of moisture inside the housing and the pressure of the brushes on the slip rings shall be high enough to obtain a self-cleaning effect during operation.

The driving motor must be provided with a weatherproof emergency stop push button station mounted on the bridge in close proximity to the bridge access ladder. The supply and installation of cables between the motor, emergency push button station, brush gear and kingpost, shall form part of this Contract. The cable shall be installed in a grade 304 stainless steel conduit mounted on the underside of the bridge and secured to the bridge by means of stainless steel conduit saddles.

ECIS 10 SURGE PROTECTION – ELECTRONIC DEVICES

The section is to be read in conjunction with the Particular Specifications of Electrical distribution systems.

Electronic equipment shall be adequately protected on both the incoming and outgoing terminals by means of suitable arrestors compatible with the relevant equipment. 4-20mA signal cables shall be protected on both sides of the cable against surges.

Surge protection shall be provided as specified at flow meters, level sensors and other electronic instruments.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The following surge arrestors shall be supplied and installed for surge protection complete with base element.

ECIS 10.1 Flow meters, level sensors and electronic instruments (4-20ma)

A combined lightning current and surge arrester module with Din rail mounted base and removable surge arrester module. The surge arrestors shall be of sufficient voltage rating and shall withstand a total discharge current of 8/20 magnitude and 20kA rating and a total impulse current of 10/350 magnitude.

At flow meter and level sensor position as well as at the termination point in the MCC/DB)

ECIS 10.2 Earthing at flow meters and level sensors

Apart from earthing already specified the following earthing system shall form part of the installations.

ECIS 10.2.1 At flow meter and level sensor

The earth connection and surge arrester earth at the flow meters/level sensors shall be connected to an earth mat comprising of 70mm² bare copper conductors installed in a cross configuration with the earth mat centre Cad welded to the 16mm² earth connection at the flow meter. The cross radial shall be at least 2m long with the radial ends connected to a 1,5m long earth spike driven into the ground at each end.

ECIS 10.2.2 Outdoor connection boxes at level sensors and flow meters

The outdoor type connection boxes required at flow meters and level sensors positions for cable connections to surge arrestors shall be equal and similar to the following:

Raised lid type with IP65 rating and equipped with mounting rail for surge arrestors and Teflon compression glands for unarmoured cables and brass compression glands for armoured cables.

All cables in manholes and valve chambers shall be mounted on heavy-duty cable racks.

ECIS 11 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x "soft copies" of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

ECIS 12 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

- a) Wiring diagrams.
- b) General layouts and Schematic single line diagrams.
- c) Elevations showing dimensional information including details such as, but not limited to, the following:
 - height (less any removable lifting angles or eyes)
 - widths
 - depth
- d) Structure descriptions showing the following:
 - Other information as required for approval.
- e) Conduit locations
- f) Unit descriptions
- g) Nameplate information
- h) Manufacturer drawings shall be provided in PDF format
- i) Data sheets and publications on all major components including, but not limited to, the following:
 - Instrumentation
 - Pipe connections
 - Instrumentation
 - Additional comments required
 - All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

ECIS 13 MEASUREMENTS AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below.

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ECIS 13.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For control and instrumentation, design information shall include, but limited to as listed in this Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) The Contractor will provide the general layout drawings and wiring diagrams of the enclosure and instrumentation for approval to the Engineer.	Sum
(b) Provide operating and maintenance manuals, data sheets of all equipment and “as built” drawings	Sum

ECIS 13.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For control and instrumentation, the rate tendered shall be for the complete control and instrumentation and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	Each
(b) Supply and delivery to site of a level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c) Supply and delivery to site respectively one of the following flow meter instruments: a) ultra-sonic flow meter, b) turbine flow meter, c) magnetic flow meter and d) Thermal flow meter with kiosk, controller [if required] and electrical equipment as specified	Each

ECIS 13.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install

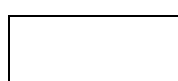
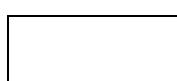
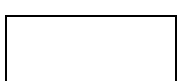
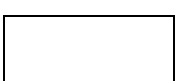
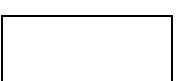
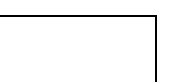
of Programmable Logic Controllers system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the PLC system complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of Programmable Logic Controller System but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	Each
(b) Site installation of a complete level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c) Site installation of respectively one of the following flow meter instruments: a) ultra-sonic flow meter, b) turbine flow meter, c) magnetic flow meter and d) Thermal flow meter with kiosk, controller [if required] and electrical equipment as specified	Each

ECIS 13.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standards of commissioning".

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	Each
(b) Commissioning of a complete level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c) Commissioning of respectively one of the following flow meter	Each

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

instruments: a) ultra-sonic flow meter, b) turbine flow meter, c)
magnetic flow meter and d) Thermal flow meter with kiosk, controller
[if required] and electrical equipment as specified

END OF SECTION

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

EG&M GENERAL AND MISCELLANEOUS

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EG&M GENERAL AND MISCELLANEOUS

EG&M 1 STANDARDS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Standard No.	Description
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1063	Earth rods and couplers
SANS 1213	Mechanical cable glands
SANS 1433-1	Electrical terminals and connectors Part 1: Terminal blocks having screw and screwless terminals
SANS 1433-2	Electrical terminals and connectors Part 2: Flat push-on connectors
SANS 10142	Code of Practice for the wiring of Premises
SANS 10199	The design and installation of an earth electrode
SANS 10292	Earthing of low-voltage distribution systems
SANS 10313	Protection against lightning - Physical damage to structures and life hazard
SANS 60947-5-2	Low-voltage switchgear and control gear Part 5-2: Control circuit devices and switching elements - Proximity switches

EG&M 2 GENERAL REQUIREMENTS

EG&M 2.1 Laws, Regulations and Codes of Practice to be Observed

The work shall be carried out strictly in accordance with the following laws and regulations where applicable;

- The latest edition of "Code of Practice for the Wiring of Premises", SANS 10142, as amended;
- Occupational Health and Safety Act (Act No. 85 of 1993);
- The "Electricity Supply By-Laws and Regulations" of the Local Supply Authority;
- The local Fire-Office Regulations;
- The Requirements of the Department of Communications;
- The Acts and Regulations applicable to the use of explosives;
- "The Code of Practice for the Installation and Maintenance of Electrical Equipment used in Explosive Atmospheres"

The Contractor will be responsible for serving all notices and paying all fees due in terms of the above laws and regulations.

EG&M 2.2 Radio and TV Interference

All equipment installed under this Contract shall comply with the Government Notice No. R.2246 and any other applicable rules and regulations in respect of radio and TV interference. Any

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost.

EG&M 2.3 Interchangeability

All equipment must be manufactured to such close tolerances that all similar components and spares must be fully interchangeable without any further alterations or adjustment being necessary.

EG&M 2.4 Water and Debris Accumulation

All outdoor equipment shall be designed so that water and debris will not readily accumulate to cause deterioration of equipment or an electrical discharge hazard. Where this cannot be avoided, such places shall be easily accessible for cleaning.

EG&M 2.5 Colour and Finishing

All metal parts of equipment shall either be finished in baked enamel or powder coating or galvanized (depending on the circumstances) after manufacture and treatment to SANS 064.

Colours of paint to be used shall be confirmed with the Engineer prior to application.

All steel areas subjected to corrosive atmospheres must be hot dip galvanized. The galvanizing must be clean, smooth, of uniform thickness and unblemished. The galvanizing must not affect the mechanical properties of the covered metal.

All drilling, welding, cutting and bending must be complete and the metal must be cleaned of any machining blemishes, mill scale, rust and lubricants before galvanizing. If site trimming, drilling and cutting cannot be avoided then all such denuded surfaces must be dressed with a cold galvanizing paint.

The Engineer must approve any other proposed corrosion protection before it is applied.

Galvanized areas must be kept free of lubricants.

Wire must be galvanized.

EG&M 2.6 Inspections And Tests

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection and all safety clothing prescribed by the Engineer.

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

EG&M 2.7 Performance Tests

On completion of erection and installation the Contractor must carry out the following tests, where applicable, in addition to any other tests, which may be specified elsewhere:

Before commissioning:

- Cable Insulation test.
- Earth continuity test.
- Tests for correct direction of rotation of motors and reverse if necessary.
- Test for correct operation of control gear, setting of overload protection equipment, etc.
- The Contractor must obtain SABS test certificates for samples of insulating oil in HT switchgear and transformers. These certificates must be submitted to the Engineer.

On completion of installation and putting into proper operation all the plant and equipment, the Contractor will be required to make suitable arrangements for the testing of all plant and equipment supplied under this Contract and running the plant for at least one week, during which time he shall also train all the operators in the correct running of the plant. He shall also explain the maintenance manuals to the operator during this time.

The entire cost of testing, including supply of test equipment, must be borne by the Contractor and an adequate allowance for such tests must be made in the Tendered price.

EG&M 2.8 Operating And Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions.

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

relevant suppliers;

- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

The format for the operating and maintenance manual is described in detail elsewhere in this document.

N.B. The prices Tendered in the Schedule of Prices will be held to include for the supply of these operating and maintenance instructions.

EG&M 2.9 Spares

Tenderers shall submit on the appropriate Schedule in this document a list of spare parts and special tools, which is recommended and should be kept by the Employer for maintenance of the plant. Spares, which the Employer decides to order, must be manufactured simultaneously with the rest of the equipment and be subjected to the same tests for dimensions, tolerances, strength, etc. All spares and special tools must be packed separately and the cases appropriately marked. All spares and special tools must be new and unused and where possible should be standard to all sections of the plant.

EG&M 2.10 Labels And Inscriptions

The standard labels on equipment regarding the manufacturer, type, class, rating etc., shall be accepted unchanged.

Engraved laminated plastic labels shall however be provided to indicate a numbering system for relays, fuses, links, lights and selector and control switches and shall correspond to the wiring diagram numbering system. These labels shall be fixed with screws, bolts or rivets.

EG&M 2.11 Name Tags

Identification tags shall be attached to all equipment, sub-assemblies, components such as instruments, fuses etc., cable ends etc. The tags shall be screwed on with brass or plated steel screws (no self-tapping screws will be permitted). Where it is not possible to use screws such as on the cables, other means of attachment must be submitted for approval to the Engineer.

Cables shall be tagged at either end, whether the end terminates in a distribution board or an end box.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All cable cores and internal panel wiring shall be identified at both ends by means of durable colour coded wire marking ferrules in accordance with numbering systems in cable and wiring diagrams. Only closed ring interlocking type identification ferrules shall be used.

Outdoor tags shall be of stainless steel or brass type.

Tags mounted indoors or protected by an enclosure shall be made of Ivorene or similar sandwich material with black letters on a white background.

All lettering and text shall be approved by the Engineer.

Letter sizes must be compatible with the application, e.g.

For fuses, terminals, relays etc	3 to 5 mm
For panels or cubicles	12 to 20 mm
For switchboard or MCC board names	about 50 mm
For building or structure names	about 80 mm

EG&M 3 EMERGENCY STOP PUSH BUTTONS AND WEATHERPROOF ISOLATORS

Each of these units shall consist of a totally enclosed outdoor type heavy duty "push and turn to lock" stop push button station with a cable gland entry at the bottom to accommodate a 4 core 2,5mm² LT PVC SWA PVC cable.

This push button station and weatherproof isolator shall be mounted on a rigid 1meter high grade 304 stainless steel pedestal with 2mm radius rounded edges, designed to be bolted to a concrete floor. (Refer to the relevant drawing.)

An emergency stop push button station shall be installed near the coupling between each motor and its associated pump and shall be connected to the relevant starter panel via the specified cable to stop the motor.

The pedestal shall be securely bolted to the floor by means of stainless steel foundation bolts grouted into the concrete and care shall be taken to ensure that it is installed plumb.

Emergency stop pedestals for submersible pump sets shall be large enough to accommodate a motor cable termination box to facilitate submersible motor cables on DIN rail mounted termination blocks

EG&M 4 CONDUCTOR ENDS

EG&M 4.1 Numbering Of Conductor Ends

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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Every conductor end whatsoever, with the exception of AC power cables at any terminal shall be numbered.
These numbers shall correspond with those on the circuit diagram and shall consist of the slip on type numbering system (clipped on numbering system will not be accepted). It shall not be possible to remove the number holder without damaging it or cutting off the lug.

EG&M 4.2 Connection Of Conductor Ends

All conductors whatsoever shall be connected at terminals by means of lugs and/or ferrules suitable for the specific conductor and terminal.

EG&M 5 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

EG&M 6 LIGHTNING PROTECTION

EG&M 6.1 Plant

The lightning protection of the lighting structures, poles and plant of the works, including all the buildings and handrails on the new plant, form part of this contract.

The lightning protection must be a SABS approved scheme and SABS approved drawings of the scheme must be submitted to the Engineer.

EG&M 7 SURGE PROTECTION

Tenderers shall allow in their Tender prices for adequate protection of the equipment supplied and installed under this contract against direct as well as induced voltage surges and spikes which may be experienced on the system.

Surge arrestors shall be provided on each phase as well as neutral on the incoming power supply terminals of each board.

All arrestors shall be connected directly to earth along the shortest possible route and only conductors of adequate rating for the discharge currents catered for shall be used for connections to arrestors.

Tenderers shall submit full particulars of the arrestors offered as well as written confirmation that it will provide adequate protection for the relevant equipment against possible voltage surges and spikes on the system.

EG&M 7.1 Surge Protection Units

The following surge arrestors shall be supplied and installed for surge protection complete with base element.

EG&M 7.1.1 Main Supply Protection

Single Din rail mounted mains surge arrestors shall be supplied and installed for each phase and neutral conductor of an electrical board. The surge arrestors shall be of sufficient voltage rating and shall withstand a max discharge current of 8/20 magnitude and 40kA rating.

EG&M 8 NOTICES AND DANGER PLATES

EG&M 8.1 Scope

This specification deals with the provision of Notices and Danger Plates as required in terms of the Occupational Health and Safety Act No. 85 of 1993, as well as any other notices that may be required by law or by the nature of the finished Works.

The following standard specifications are referred to in this specification: -

- SANS 10140; Parts I to IV: Identification colour marking.
- SANS 1186: Symbolic safety signs.
- Occupational Health and Safety Act No 85 of 1993

EG&M 8.2 Materials and Finish

Outdoor signs shall be either of vitreous enamelled type or of cast aluminium with raised or embossed letters.

Indoor notices shall be of non-deteriorating plastic, Perspex or fiberglass.

The colours and sizes of letters and colours of background shall be in accordance with requirements of SANS 0140 and as approved by the Engineer.

Symbolic signs shall conform to the requirements of SANS 1186.
Signs shall be pre-drilled for fixing.

All fixing accessories shall be of non-corrosive material.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EG&M 8.3 Installation and Erection

The Contractor shall supply and fix permanently in position the signs and notices required by law for all the relevant working areas of the Works. The Engineer shall as prescribed by the relevant Regulations and as agree positions of signs.

EG&M 9 FIRE EXTINGUISHERS

5kg CO2 and powder fire extinguishers shall be supplied and installed in all pump stations and treatment plant buildings in accordance with the requirements of the Local Authority.

Contractor

Witness 1

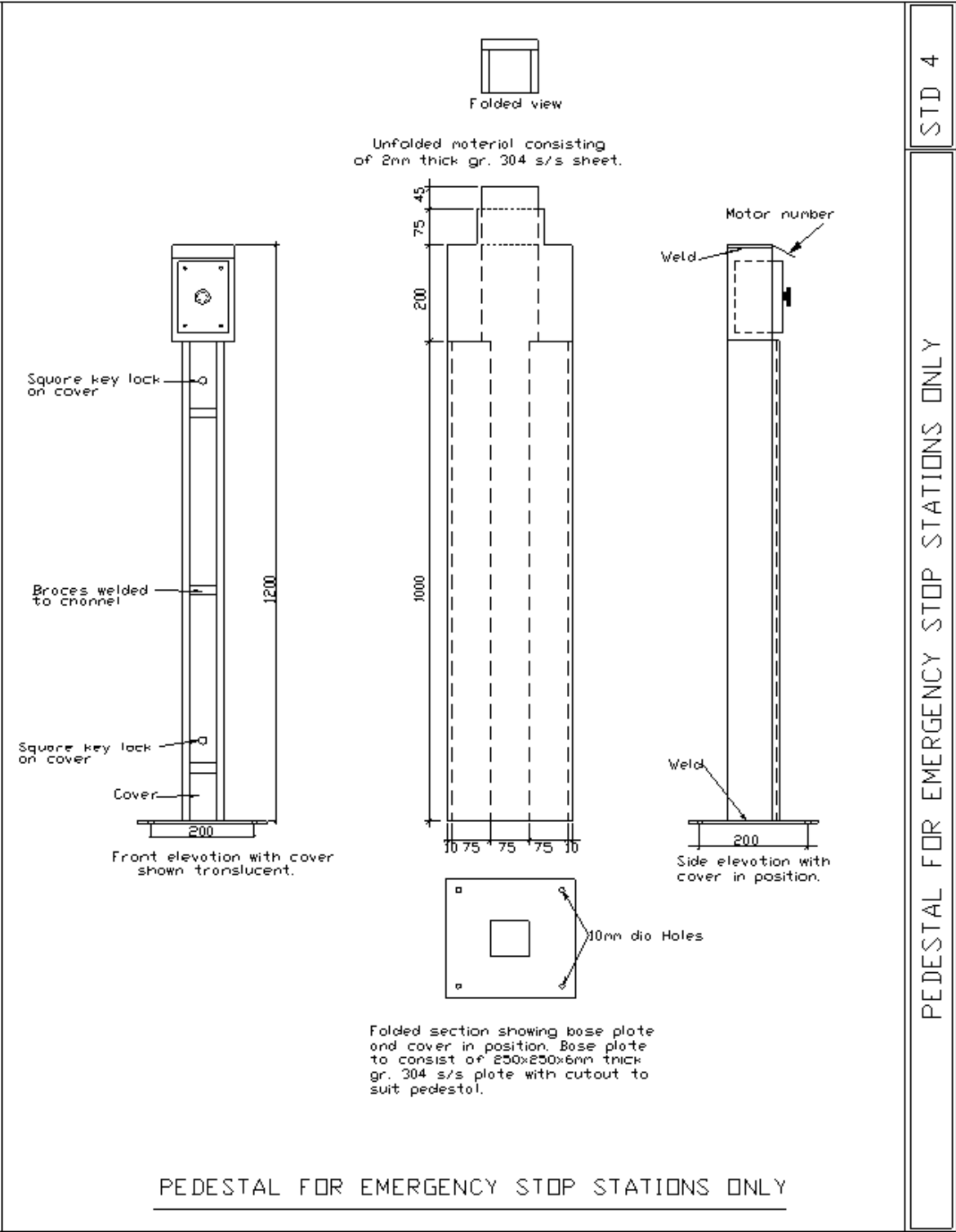
Witness 2

Employer

Witness 1

Witness 2

EG&M 10 PEDESTAL FOR EMERGENCY STOP AND START STATIONS ONLY



EG&M 11 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x "soft copies" of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EG&M 12 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

- a) Wiring diagrams.
- b) Schematic single line diagrams.
- c) Elevations showing dimensional information including details such as, but not limited to, the following:
 - E-stop and notices height (less any removable lifting angles or eyes)
 - E-stop and notices height width
 - E-stop and notices height depth
- d) Structure descriptions showing the following:
 - Other information as required for approval
- e) Conduit locations
- f) Unit descriptions
- g) Nameplate information
- h) Manufacturer drawings shall be provided in PDF format
- i) Data sheets and publications on all major components including, but not limited to, the following:
 - Pilot devices
 - Relays
 - All clarifications and exceptions must be clearly identified

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

EG&M 13 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EG&M 13.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For general and miscellaneous, design information shall include, but limited to as listed in this Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide general layouts drawings, notice drawings and wiring diagrams of the for approval.	Sum
(b) Provide operating and maintenance manuals, data sheets of all equipment and "as built" drawings	Sum

EG&M 13.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For general and miscellaneous, the rate tendered shall be for the complete general and miscellaneous and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of emergency stop station [Refer to EG&M 10]	Each
(b) Supply and delivery to site of emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c) Supply and delivery to site of fire extinguishers	Each
(d) Supply and delivery to site of all notices as may be required and specified	Sum
(e) Supply and delivery to site of all earthing requirements in terms of hand rails and building lightning protection as required and specified	Sum

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EG&M 13.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of general and miscellaneous equipment shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the general and miscellaneous complies with the requirements and serves the intended purposes. Comply with the requirements of OHSA, SABS and IEC standards and applicable portions of "Standard of Installation", for installation of general and miscellaneous but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of a complete emergency stop station [Refer to EG&M 10]	Each
(b) Site installation of a complete emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c) Site installation of a complete fire extinguisher	Each
(d) Site installation of a complete all notices as may be required and specified	Sum
(e) Supply and delivery to site of all earthing requirements in terms of handrails and building lightning protection as required and specified	Sum

EG&M 13.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

(a) Commissioning of a complete emergency stop station [Refer to EG&M 10]	Each
(b) Commissioning of a complete emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c) Commissioning of a complete fire extinguisher	Each
(d) Commissioning of all notices as may be required and specified	Sum
(e) Commissioning of all earthing requirements in terms of handrails and building lightning protection as required and specified	Sum

END OF SECTION

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

EPTM: TELEMETRY SYSTEM

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Contractor

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Witness 2

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Contractor

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Employer

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EPTM TELEMETRY SYSTEM

EPTM 1 SCOPE OF WORKS

As specified in the Project Specifications.

EPTM 2 STANDARDS AND TESTS

The motor control centres shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
EMCC	Particular Specifications for Motor Control Centres and Distribution Boards
EELP	Earthing and Lightning Protection
ETSI EN 301 489-4 V1.4.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services;
ETSI EN 300 019-1-1 V2.1.4	Classification of environmental conditions; Storage. Class 1.2, weather protected;
ETSI EN 300 019-1-2 V2.1.4	Classification of environmental conditions; Transportation. Class 2.3, public transportation;
ETSI EN 300 019-1-3 V2.1.2	Classification of environmental conditions; Stationary use at weather protected locations. Class 3.2, partly temperature controlled locations;
ETSI EN 300	Classification of environmental conditions; Stationary use at non-weather protected locations;
ETSI EN 300 132-2 V2.1.2	Equipment Engineering (EE); Power supply interface at the input to telecommunication equipment; Part 1: Interface operated by Direct Current (DC);
ETSI EN 302 217-1 V1.1.1	Overview and system-independent common characteristics;
ETSI EN 302 217-2-1 V1.1.1	System-dependent requirements for digital systems operating in frequency bands where frequency co-ordination is applied;
ETSI EN 302 217-2-2 V1.1.1	Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for digital systems operating in frequency bands where frequency co-ordination is applied;
CENELEC EN 60950	Safety of information technology equipment;
CENELEC EN 60215	Safety requirements for radio transmitting equipment;

Contractor

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Employer

Witness 1

Witness 2

Standard No.	Description
CENELEC EN 60825-1	Safety of laser products, Part 1: Equipment classification, requirements and user's guide;
CENELEC EN 60825-2	Safety of laser products, Part 2: Safety of optical fibre communication systems;
ITU-R Rec. F.746-7	Radio-frequency channel arrangements for fixed service systems;
ITU-R Rec. F.1099-3	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the 5 GHz (4 400-5 000 MHz) band;
ITU-R Rec. F.383-7	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band
ITU-R Rec	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band
ITU-R Rec. F.385-8	Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band
ITU-R Rec. F.386-6	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the 8 GHz band
ITU-R Rec. F.387-9	Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band
ITU-R Rec. F.497-6	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band;
ITU-R Rec. F.636-3	Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band
ITU-R Rec. F.595-8	Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz band
ITU-R Rec. F.637-3	Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band
ITU-R Rec. F.748-4	Radio-frequency channel arrangements for radio-relay systems operating in the 25, 26, and 28 GHz bands
ITU-R F.1520-2	Radio-frequency arrangements for systems in the fixed service operating in the band 31.8-33.4 GHz
ITU-R Rec. F.749-2	Radio-frequency channel arrangements for radio-relay systems /+ operating in the 38 GHz band
ITU-R Rec. F.750-4	Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based network

Contractor

Witness 1

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Employer

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Standard No.	Description
ITU-T Rec. G.703	Physical/electrical characteristics of hierarchical digital interfaces
ITU-T Rec. G.823	The control of jitter and wander within digital networks which are based on the 2048 Kbit/s hierarchy
ITU-T Rec. G.825	The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)
ITU-T Rec. G.826	Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
ITU-T Rec. G.828	Error performance parameters and objectives for international, constant bit rate synchronous digital paths
ITU-T Rec. G.921	Digital Sections based on the 2048 Kbit/s hierarchy
ITU-T Rec. G.957	Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
ITU-T Rec. G.958	Digital line systems based on the synchronous digital hierarchy for use on optical fibre cable
ETSI TR 101 036-1 V1.3.1	Fixed Radio Systems; Point-to-point equipment; Generic wordings for standards on digital radio systems characteristics; Part 1: General aspects and point-to-point equipment parameters
CEPT/ERC Rec. 74-01 E	Spurious Emissions
CEPT/ERC Rec 14-01 E	Radio-frequency channel arrangements for high capacity analogue and digital radio relay systems operating in the band 5925 MHz – 6425 MHz
CEPT/ERC Rec 14-02 E	Radio-frequency channel arrangements for medium and high capacity digital radio relay systems operating in the band 6425 MHz – 7125 MHz
CEPT/ECC Rec 02-06	Preferred channel arrangement for digital fixed service systems operating in the frequency range 7125-8500 MHz
CEPT/ERC Rec. 12-06 E	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.7 – 11.7 GHz
CEPT /ERC/REC 12-02	Harmonised radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 12.75 GHz to 13.25 GHz
CEPT/ERC/REC 12-07 E	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the bands 14.5 - 14.62 GHz paired with 15.23 - 15.35 GHz

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Standard No.	Description
CEPT/ERC/REC 12-03	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17.7 GHz to 19.7 GHz
CEPT T/R 13-02	Preferred channel arrangements for fixed services in the range 22.0-29.5 GHz
IEC 297-2	Dimensions of mechanical structures of the 486.6 mm (19 in) series: Cabinet and pitches of the rack structures
IEC 297-3	Dimensions of mechanical structures of the 486.6 mm (19 in) series: Sub-rack and associated plug in units"
IEC 60169-16	Radio-frequency connectors. Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling - Characteristic impedance 50 ohms (75 ohms)
IEC 60169-29	Radio-frequency connectors - Part 29: Miniature R.F. coaxial connectors with screw-, push-pull and Snap-on coupling or slide-in rack and panel applications; Characteristic impedance 50 ohms
IEC 60603-7	Connectors for electronic equipment - Part 7-1: Detail specification for 8-way, shielded free and fixed connectors with common mating features, with assessed quality
IEC 60835-2-8	Methods of measurement for equipment used in digital microwave radio transmission systems - Measurements on terrestrial radio-relay systems - Adaptive equalizer
IEEE 802.3	Carrier Sense Multiple Access with Collision Detection
FCC 47 CFR Part 101	Fixed Microwave Services
SRSP – 305.9	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band 5915 – 6425 MHz
SRSP – 306.4	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band – 6425 – 6930 MHz
SRSP – 307.1	Technical Requirements for Fixed Line-of-Sight Radio Systems Operating in the Band 7125-7725 MHz
SRSP – 307.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 7725-8275 MHz
SRSP – 310.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 10.7-11.7 GHz
NRFP-18	ICASA National Radio Frequency Plan

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EPTM 3 RADIO AND TV INTERFERENCE

All equipment installed under this Contract shall comply with the Government Notice No R.2246 and any other applicable codes, rules and/or regulations in respect of radio and TV interference.

Any equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost

The National Radio Frequency Plan-208 allocates the Radio Frequency Spectrum to Radio Services in the Frequency Bands between 8.3 kHz and 3000 GHz. The Contractor will include his price all frequency assignments which shall be in accordance national radio frequency plan and shall be registered.

EPTM 4 PRE – MANUFACTURE SUBMITTALS

EPTM 4.1 Manufacturer Drawings

Telemetry outstations elevations showing dimensional information including details such as, but not limited to, the following:

1. Telemetry outstation height (less any removable lifting angles or eyes);
2. Telemetry outstation width;
3. Telemetry outstation depth;
4. Location of shipping splits;
5. Dimensions.

EPTM 4.2 Structure Descriptions Showing the Following

1. Rating of equipment;
2. Enclosure ratings;
3. Short-circuit withstand ratings;
4. Cascaded systems;
5. Type 1, type 2 or full coordination system;
6. IP Rating;
7. Radio
8. Other information as required for approval.

EPTM 4.3 Product Data

Data sheets and publications on all major components including, but not limited to, the following:

1. Motor starters;
2. Overload relays;
3. Circuit breaker and fuse information including time current characteristics;
4. Control power transformers;
5. Pilot devices;

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

6. Relays;
7. Timers;
8. Radios;
9. Antennas;
10. Programmable logic Controllers;
11. Digital Input, Digital Output, Analogue Input, Analogue Output, Voltage Free Contact and RTD's Devices;
12. Multicore cables and earth wires;
13. Glands;
14. Indication lights;
15. Terminal blocks.

EPTM 4.4 Specifications Response

All clarifications and exceptions to the project specifications must be clearly identified and marked up on the drawing.

EPTM 4.5 Specifications Response

Provide a copy of the manufacturer's installation instructions that includes but not limited to, the following:

1. Receiving, handling, and storage instructions;
2. Nameplate data, serial numbers, UL markings, and short circuit ratings;
3. Installation procedures including splicing procedures, terminations and connections;
4. Conduit and cable installation;
5. Installing and removing plug-in units;
6. Operation of operator handles and unit interlocks;
7. Checklist before energizing;
8. Procedure for energizing equipment;
9. Maintenance procedures.

EPTM 4.6 Final Submittals

1. The Contractor shall provide certification that the all components or Telemetry outstation has been installed in accordance with the manufacturer's instructions and with local codes and standards that govern South Africa and all listed standards.
2. Test reports indicating manufacturer's standard testing was performed.
3. Installation/operation instructions for major components.
4. Telemetry System spare parts listing and pricing
5. Technical details and descriptive literature regarding all equipment and instruments offered;
6. Three paper prints of all of the above for final hand-over.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

All settings as above detailed shall be indicated on the final drawings.

EPTM 5 DELIVERY, STORAGE AND HANDLING

The contractor shall coordinate with the Engineer manufacturer for entry into the building.

The contractor shall store the telemetry system cubicles in a clean, dry, and heated space.

The contractor shall protect the units from dirt, water, construction debris, and traffic.

During storage the contractor shall connect internal space heaters (if specified) with temporary power.

EPTM 6 EQUIPMENT MANUFACTURER

EPTM 6.1 SABS Certifications

The manufacturer equipment shall be certified by South African Bureau of Standards or accredited testing facility which is to approval of the Engineer in manufacturing. If the contractor does not have certification, it will be to the cost of the contractor to test the telemetry system at South African Bureau of Standards at the Contractors cost.

The Contractor shall have certificates from South African Bureau of Standards which is higher or is equal to the specified equipment.

EPTM 6.2 Outstation Cabinets

All equipment shall be housed in epoxy coated 2,0mm thick 3CR12 steel dust and vermin proof cabinets. The cabinets shall have front access only. Cable entrance shall be possible from the bottom. The doors must be fitted with tamper proof locking catches with padlock facilities and shall be of the 3 point type. Concealed chromed steel hinges shall be used on the front door.

The systems shall be designed to allow for 30% for future extensions.

EPTM 6.2.1 Indoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty rust proof hinges.

Each panel shall be supplied with concealed hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be Cadmium plated. The use of self-tapping screws will not be permissible.

EPTM 6.2.2 Outdoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy-duty stainless-steel hinges.

Each panel shall be supplied with concealed stainless-steel hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors, the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

All screws, studs, bolts, nuts and washers used for these boards shall be stainless steel plated. The use of self-tapping screws will not be permissible.

The outdoor motor control boards shall be constructed of at least 2mm powder coated 3CR12 steel. Vermin proofed IP 55 rated ventilation openings shall be provided in doors and side panels. A 3CR12 roof shall be added to all outdoor motor control centres and distribution boards with a minimum slope of 1/10.

EPTM 6.2.3 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in an outdoor distribution or motor control board, this equipment shall be installed in a separate and special compartment and all wiring shall be terminated on rail mounted terminal strips for field connection of all monitoring and control cables.

The doors of this compartment must be labelled: "Electronic Equipment".

All the electronic equipment but not limited to HMI, power supply, PLC CPU, Ethernet switch, fibre switch, all I/O cards, UPS and telemetry and 30% additional space for the future. All equipment shall be mounted flush behind a common hinged panel, with laminated, shatterproof and tinted glass for viewing purposes.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer's requirements are met.

The tier shall be designed to house all of the above equipment, and the manufacturer shall coordinate with communication and instrumentation specialist.

EPTM 6.2.4 Treatment And Painting Of Metal Parts

All metal parts shall be treated before powder coating in accordance with standard corrosion protection standards and the appropriate coating system shall be selected for the specific application. Motor control centre outer surfaces shall be powder coated colour B26, SANS 1091. (Electric orange)

An average of 2 mil thick electrostatic powder paint coat shall be applied, the contractor shall have a Rugged, fully electronic coating thickness gauges present for testing the thickness of the paint.

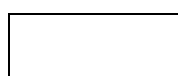
EPTM 7 GENERAL REQUIREMENTS

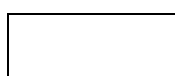
EPTM 7.1 Internal wiring

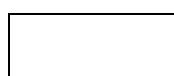
The internal wiring of the boards shall consist of coloured PVC-insulated conductors of adequate copper cross-section, which shall be neatly installed horizontally and vertically in PVC trunking. Numbered ferrules of an approved type (clip on type not acceptable), shall be provided on each end of each wire, to facilitate the tracing of circuits.

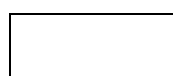
Control circuits shall be colour coded as follows;

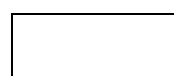
Three Phase	-	Red
Three Phase	-	Blue
Three Phase	-	White
Single Phase	-	Red
A.C. Neutral	-	Black

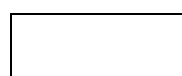

Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

Earth	-	Green and yellow
110V D.C. Positive	-	Brown
110V D.C. Negative	-	Black
24V D.C. +ve	-	Grey
24V D.C. -ve	-	Purple
4-20mA +ve	-	White
4-20mA -ve	-	Black
All other voltages	-	To be confirmed with Engineer.

EPTM 7.2 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in a distribution board and motor control centre, this equipment shall be installed in a separate and special compartment.

Sufficient room shall be provided for the rail mounted terminal strips and all wiring shall be terminated on this rail mounted terminal strips for field connection of all monitoring and control cables.

EPTM 7.3 Cable Terminations

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end and shall bear the SABS mark of approval. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double inner seals as well as waterproofing seals on nipples.

Cable armouring shall be earthed at each end but may not be used as earth continuity conductor.

Flameproof glands for indoor and outdoor use shall be used where the hazardous area classification and explosion protection rating is supplied by the Engineer.

EPTM 7.4 Labelling

A screwed on engraved label of the black on white "traffolyte" type shall be provided below each item of equipment on the front panel of each board as well as on the chassis in close proximity to the relevant equipment to identify such equipment in the English language in 6 mm high lettering.

Each board shall further be provided with a screwed on reverse engraved yellow Perspex nameplate with black 20mm high lettering to identify the board in the English language on the outside of the door at the top thereof.

EPTM 7.5 Mains Surge Arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures

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requirements. All surge arrestors shall be connection type 2 as per the latest addition of the SANS 10142.

EPTM 7.5.1 Building with External Lightning Protection

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EPTM 7.5.2 Building With NO Lightning Protection

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EPTM 7.5.3 ANTENNA Lightning Protection

The surge arrestors shall be suitable for multi frequency or for wireless applications and shall have excellent RF endurance performance or adapted to Wireless LAN and Wireless Local Loop applications for use according to the lightning protection zones concept at boundaries and higher and shall be able to withstand a lightning impulse current wave form 8/20µs at a nominal discharge current of 20kA. Shall be IEC 61643-21 complaint.

EPTM 7.6 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with the requirements of SANS Specification no. 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.

Each circuit breaker shall be provided with non-adjustable time-delayed trips.

These circuit breakers shall be fitted with copper terminal collector bars where more than one cable tail has to be terminated on the same terminal.

EPTM 7.7 Fused Switches

All fused switches shall be of the "load-breaking" and "fault-making" type complying with BS-5419 where applicable and fitted with HRC cartridge fused links to BSS-88. Auxiliary contacts shall be provided where relevant for signal purposes.

EPTM 7.8 Current Limiting Circuit Breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200kA rms at least three times.

EPTM 7.9 Current Transformers

All current transformers shall be of the air insulated type complying in all respects with the requirements laid down in BS 3938: 1973.

The contractor shall carefully select the ratio, burden and accuracy class to suit its specific application in accordance with the recommendations and requirements of BS 3938.

EPTM 7.10 Indicating Instruments

All indicating instruments shall comply with the requirements laid down in BS 89: Part I: 1970 for instruments of a 2,5 Accuracy Class. All indicating instruments shall have 96mm square dials.

The maximum demand ammeters shall be of the 6A combined maximum demand registering and instantaneous indicating type having MISC movement and thermal demand indication with an integrating time lag of 15 minutes. The ammeter scales shall be direct reading with a full-scale deflection corresponding to 120% of the rated primary current of the relevant current transformer. Each ammeter shall be clearly and indelibly marked to indicate the colour of the phase to which it is connected.

The ammeters for motor starters shall be 5A instantaneous indicating meters with MISC movement and direct reading scales. The meters shall be able to withstand over currents resulting under starting conditions and the full load current of the relevant motor shall be clearly marked in red on the face of the meter.

Voltmeters shall be of the direct reading moving iron suppressed zero type.

The power factor meters shall indicate from 0,7 lagging to 0,7 leading.

The running hour meters shall have cyclometer dials indicating up to 5 digits and two decimals. (12345,67)

EPTM 7.11 Instrument selector switch

A four-position rotary type instrument selector switch shall be mounted directly below the relevant instrument in such a way that only the selector knob and indicator plate are on the panel, and the switch itself is behind the panel.

The selector knob shall consist of Bakelite, and shall have an arrow engraved on it, indicating the switch position.

The switch shall have a positively driven switching mechanism.

The indicator plate shall consist of Bakelite and shall have the positions for the three phases and "OFF", engraved on it in 5mm high lettering.

EPTM 7.12 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "CLASS II MECHANICAL DUTY CLASS / TYPE 2 COORDINATION" and "A3 Make and Break Category".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EPTM 7.13 Time Switches

The time switches shall be suitable for use on a 231 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 231 V.

EPTM 7.14 Isolators

All isolators shall be of the "Load-breaking" and "fault making" type and shall comply with the requirements of BS 5419-1977 where applicable. Where relevant, isolators shall be provided with auxiliary contacts for signal purposes.

EPTM 7.15 400 Volt Air-Break Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of IEC 158-1 for Class AC 3 contactors of Intermittent Duty Class 0,3.

All contactors shall be provided with arc extinguisher and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with a 240 Volt, 50 Hz closing coil suitable for continuous operation and at least 15 closing operations per hour. In rural areas contactor coils must be rated to operate satisfactorily between 75% and 130% of nominal voltage.

An adequate number of auxiliary contacts shall be fitted.

The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EPTM 7.16 Earth Leakage Units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

EPTM 7.17 Terminals

Terminals may be of the bolted type otherwise they shall be of rail mounted clamp type.

All types of terminals and their insulation shall have a minimum comparative creep index of 500 to BS 3781.

EPTM 7.18 Clamp Type Terminals

These terminals shall be not less than 8 mm wide.

Screws and connectors shall be electroplated to prevent corrosion. The connectors shall be such that the screws will not loosen due to vibration. Current carrying parts shall be of serrated silver-plated copper or brass. Only one connection shall be allowed per connector. For more connections the number of terminals shall be increased, and bridge pieces shall be used.

EPTM 8 RADIO SELECTION SLOW SPEED

The radio transceivers shall be of robust construction with Ethernet communication technology for increased data throughput. On an upgrade on an existing telemetry system similar radio communication systems shall be incorporated.

Ethernet communication technology shall be used.

EPTM 8.1 Radio Selection Medium Speed

Industrial protocols will be supported including Ethernet/IP, Modbus TCP/RTU, Profibus DP and Profinet CBA. The Wireless Ethernet Modem further simultaneously functions as a wireless serial modem (RS232/485) providing secure, reliable short- and long-range communication solutions.

Capable of operating in Access Point/Client configuration, functioning as a network Bridge/Router, or serving as a Serial Server (RS232/485), the radio shall offer node to node deterministic mesh network repeatability for further range and multiple channel spacing options to increase network scalability. Radio Integrated Modbus server capability shall allow for all seamless I/O expansion modules.

Industrial applications requiring robust wireless Ethernet connectivity in process/automation applications connecting to PLC's, DCS/SCADA, or field instruments with Ethernet as well as RS232/485 interfaces. Powerful built-in diagnostics and universal industrial connectivity options in a highly configurable platform

2.4-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for medium speed radios. 20-MHz channel with 5-MHz channel spacing from the available 13 channels, starting with the first channel centered on 2.412 GHz.

5-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for High-speed radios. The permitted channel usage shall be confirmed in the country.

EPTM 8.2 Radio Selection High Speed

Industrial protocols will be supported including Ethernet/IP, Modbus TCP/RTU, Profibus DP and Profinet CBA. The Wireless Ethernet Modem further simultaneously functions as a wireless serial modem (RS232/485) providing secure, reliable short and long range communication solutions.

Capable of operating in Access Point/Client configuration, functioning as a network Bridge/Router, or serving as a Serial Server (RS232/485), the radio shall offer node to node deterministic mesh network repeatability for further range and multiple channel spacing options to increase network scalability. Radio Integrated Modbus server capability shall allow for all seamless I/O expansion modules.

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Industrial applications requiring robust wireless Ethernet connectivity in process/automation applications connecting to PLC's, DCS/SCADA, or field instruments with Ethernet as well as RS232/485 interfaces. Powerful built-in diagnostics and universal industrial connectivity options in a highly configurable platform

5-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for High speed radios. The permitted channel usage shall be confirmed in the country.

EPTM 9 SOLAR PANEL AND BATTERIES

Where no electrical supply is available solar panels shall be used to charge batteries via a voltage regulator. A fully operational backup time of 96 hours (4 days) is required unless otherwise specified. Solar panels shall be installed at a radio communication.

The regulator shall be specifically designed for the telemetry use, where radio current draw varies for short durations of transmission. Allowance shall be made for at least 4 station interrogations per hour.

The regulator shall provide

- Over voltage cutout of load if battery voltage is greater than 16V.
- Cyclic charge to keep battery voltage falls below 10V for more than 30 seconds.
- Low voltage cutout of load if battery voltage falls below 10V for more than 60 seconds. Load is reinstated when battery is charged to more than 12V dc.

Batteries shall be selected for the purpose of the application. High peak discharge current during radio transmission shall be used for battery selection. Typically [Nickel Cadmium] batteries shall not be used.

Sealed lead-acid batteries shall be used for capacities up to 65Ampere Hour, and vented lead-acid (Plant) storage cells designed for standby applications shall be used for larger capacities. Liquid based storage cells shall be housed in a separate vented lockable enclosure.

EPTM 10 EARTHING AND LIGHTNING PROTECTION

Shall be done accordance to earthing and lightning protection particular specifications.

EPTM 11 SOLENOID VALVES

Solenoid valves complete with hydraulic pipe couplings shall be provided where indicated for telemetry control of hydraulic controlled valves at reservoir sites. These units shall operate from a 24V DC supply and shall be of the low energy consumption type. The open/close status of the hydraulic valve shall be monitored where possible by means of a limit switch mounted on the hydraulic valve casing. A weatherproof cable termination box must be supplied and installed next to the control valve and provision must be made for connection cables between the termination box, solenoid and limit switch. The control valve will be controlled by means of the level sensor at the relevant reservoir and must be a fail safe operation (valve must close in the event of a power failure).

EPTM 12 NUMBERING OF CONDUCTOR ENDS

Every conductor end whatsoever, with the exception of AC power cables at any terminal shall be numbered. The alphanumeric numbering shall be in accordance with - BS 158 - 1961.

These numbers shall correspond with those on the circuit diagram and shall consist of the slip-on type numbering system (clipped on numbering system will not be accepted). It shall not be possible to remove the number holder without damaging it or cutting off the lug.

EPTM 13 CONNECTION OF CONDUCTOR ENDS

All conductors whatsoever shall be connected at terminals by means of lugs and/or ferrules suitable for the specific conductor and terminal.

EPTM 14 MONITORING SYSTEM

EPTM 14.1 System Organisation

The system will consist of the following organisation which may in future increase in size. The system shall be suitable to be modified to a decentralised type of control with intelligent outstations.

EPTM 14.2 Monitoring

The system shall provide facilities for the monitoring of all status and analog values described as elsewhere.

EPTM 14.3 Status and Analog Indication and Alarms

The system shall provide plant information to the following display devices:

- a) Mimic and SCADA Display units

Analog readings shall be in close proximity to related devices on the display screens showing flow rates and shall be continuously updated after outstation scans.

The following indications are catered for:

- Indication of status of all motors and pumps;
- Indication of which relay or any other device caused changes in the system;
- Alarms are indicated visually and audible. When the alarm is accepted the audible indication is cancelled;
- Indication of internal faults in the supervisory system;
- When selected, indication of analog signals at specific points in the system as specified in the relevant clause; and;
- When selected, indication of time, the control equipment and outstations shall give the same indications.

- b) Data and Event Recording

The following information shall be recorded by the system:

- Automatic recording of events when a change of status takes place in the system and at the same time, recording time, date, outstation, item, alarm and identification;
- Automatically log all analogue values at preset intervals from a particular outstation;
- Automatically log any number of selected analogs at preset intervals;

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- Record keeping of the real time operation of all motors; and
- Keep records of all controls transmitted.

The data logging will be such that it can also be done by manual selection at any time.

EPTM 14.4 *Measuring Accuracies*

Measuring accuracies of 2,5% full-scale value are required on all analog signals.

EPTM 15 TRANSDUCERS AND INTERFACES

Transducers shall be supplied and installed by the contractor and any other associated devices where it may be necessary in order that supervisory analog quantities can be measured by the telemetry. The monitoring and control system contractor will be responsible for all interfaces between his equipment and that of other contractors.

EPTM 16 FAULT FINDING AND TEST FACILITIES

The equipment shall be designed in such a manner that staff of the Employer with the minimum training in electronics, can do the maintenance on the equipment.

The contractor shall specify all standard and special test equipment required for normal maintenance and testing purposes.

The contractor shall supply a logical step-by-step system of fault location.

A rail mounted terminal strip equal or similar to Klippon Type SAKR shall be mounted in the supervisory panels for the connection between the plant equipment signals and electronic equipment.

EPTM 17 MODULAR DESIGN

The system shall be of modular design in order to facilitate expansion to the system by simple plug-in of additional modules and minimum wiring changes. All modules shall be DIN rail mounted and shall be interconnected by means of bus connectors.

EPTM 18 ANTENNAE

A list must be provided showing which mast is allowed for at each station.

These shall be either:

a) Wall mounted:

A 5mm tubular mast shall be fixed to the wall with a heavy-duty gauge galvanised offset bracket for 500mm roof overhang. The mast shall be either aluminum 50mm diameter, 5mm thick, or steel galvanised 50mm diameter, 2mm thick.

b) Self-supporting 9m:

A 9m flagpole type mast suitable for the size of antenna used, to withstand 140 km/h wind loading shall be provided.

c) **Self-supporting 12 to 18m:**

Mast above 12m should be lattice type construction. The mast plinth shall be supplied by the Contractor. The contractor shall provide the concrete base with plinth and wire way. A sketch of the civil works must be provided by the Contractor.

d) **Self-supporting Above 18m:**

Mast above 18m should be lattice type construction. The mast plinth shall be supplied by the Contractor. The contractor shall provide the concrete base with plinth and wire way. A sketch of the civil works must be provided by the Contractor.

EPTM 19 OUTSTATION HARDWARE

EPTM 19.1 Operational Requirements

a) **General**

The outstation shall comprise of a central processor unit with interface modules, a power supply, standby battery and plant input and output modules and a communication system. All equipment shall be housed in a steel cabinet as specified.

Apart from any other modules being necessary to operate and control the system satisfactorily, the following modules shall be made available on the outstations.

b) **Power Supply**

The stabilized power supply and battery charger unit shall be capable of re-charging a drained batteries and shall operate from 230 V-AC.

Battery backup for at least 24 hours of normal operation shall be provided for.

General purpose battery up to 5 years in standby service shall be supplied or more than 260 cycles at 100% discharge in cycle service shall be guaranteed.

c) **Processor**

The CPU module shall have a high-speed RAM for executable program sections with a RAM size that will match the requirements of the application.

Sufficient memory shall be made available to store data for a reasonable period of time in the event of a communication failure.

The CPU module shall be equipped with a CPU watchdog timer circuit that will automatically restart the system in case of severe electrical disturbance. The CPU shall be auto-configuring and shall determine automatically which I/O modules are connected, do data addressing and mode of operation to run. Use of programmer at outstation shall not be necessary.

d) **Relay Interface Cards**

Relay interface cards shall be available to connect control outputs to outside plant.

LED monitors shall be fitted to this card to aid with fault-finding.

e) Input/Output Modules

The digital I/O modules shall accept inputs from plant controls and auxiliary multiple operations and provide control outputs to plant operations.

These modules shall also be capable to accept floating alarms of duration of as well as steady alarms from normally closed controls.

All inputs and outputs shall be 2,5 kV isolated from the logic components. Inputs and outputs shall be protected against over voltage and over current.

These I/O's shall be isolated from field equipment by means of interface relays installed in the outstation.

f) Analog Modules

These modules shall accept analog inputs from plant transducers and provide control analog outputs to plant operations and shall be capable of converting 0-5 V DC, 4-20 mA or 0-5 V AC signals by using external converters. All analog inputs and outputs shall be galvanic isolated

Surge protection modules as specified shall be installed in the out station.
RS 232 Bus connectors

These modules shall accept data from an external source. The baud rate shall be adjustable from 300, 1200, 2400, 9600 or 19200-baud handshake protocol shall include XON/XOFF, CTS/RTS and direct.

g) Outstation General

The outstation shall be capable of scanning all inputs and storing data in memory for collection by the mother station.

It must also be possible to perform sequence control and interlocking of plant equipment.

h) Outstation Antennas

Antennas shall be installed at all outstations which will suite the application, speeds shall be detailed in Project Specification.

This high-gain shall band antenna shall be used for low speeds. The antenna shall cover virtually all of the international wireless, cellular and mobile data bands.

The minimum antenna shall operate in two frequency bands 2.4 GHz and 5 GHz.

This Antenna shall have a minimum 13dBi gain at 2.4GHz band and 18dBi gain at the 5GHz band. The housing shall be made of ABS which shall have cataristic for high impact resistant plastic and is also resistant to acids and other chemicals that may occur in industrial plants.

i) Time-Tagging

Events shall be time stamped at the outstations. Only a real time clock at the outstation will be acceptable which shall be hardware based with a crystal. Accuracy of time tagged events should be 20ms between events and 100ms between events at different outstations.

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j) **Digipeating**

The telemetry system shall have the facility to repeat commands destined from or to a remote station, via another station (Digipeating, or Store-and-forward). The digipeat "map" shall be stored in E2PROM (non-volatile memory) at relevant stations, and be able to be programmed with local programmer (e.g. LAP-TOP) or remotely via the communications medium. The digipeat map shall allow for input/output data to be transferred from any remote site to any other remote site and/or Central Station.

k) **Programmable Logic Controllers**

Where logic control is required at an outstation for pump control programmable logic controllers shall be used. **Programmable Logic Controller Particular Specifications shall be followed.** These PLC's shall be of reputable brand name, to allow after sales programming support by specialist vendors. The telemetry interface to PLC will be serial communications.

EPTM 20 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door of an outdoor motor control centre or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EPTM 21 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

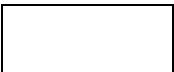
The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

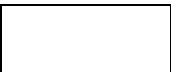
EPTM 22 TESTING OF TELEMETRY SYSTEM AT THE MANUFACTURER'S WORKS

Each telemetry outstation shall be subjected to the following tests in the manufacturer's works after manufacture:

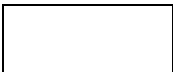
- a) A thorough inspection shall be carried out to ensure compliance with the specification and approved drawings and wiring diagrams and to ascertain that all connections are properly made.
- b) Primary and secondary injection tests shall be carried out on all switching, protection, metering interlocking and indication circuits.
- c) Load Mismatch Test, Output Open and Short Circuit Protection Test, Output Open and Short Circuit Protection Test, Linearity Test, Modulation Input Impedance Test, Modulation Sensitivity Test, Modulation Frequency Response Test, Ground Isolation Test, Turn-On and Turn-Off Characteristics Test, Occupied Bandwidth test, Transmitter Quality Test, Transmitter Phase Noise Test, Transmitter Bit Error Probability and Additive Noise at GPS Frequencies.



Contractor



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Witness 2



Employer



Witness 1



Witness 2

The manufacturer shall submit three copies of test certificates giving details of conditions and results of tests carried out to the Engineer.

EPTM 23 CONCRETE PLINTH FOR OUTDOOR TELEMETRY SYSTEM

The plinth shall be cast 150mm below as well as 150mm above the ground level. It shall have neatly bevelled edges and shall be 75mm wider than the panels all round.

An opening of sufficient width to allow for cable entry shall be provided under the starter panels.

The grade 304 stainless steel foundation bolts for mounting of the panels shall be cast or grouted into the plinth. The plinth shall be in Class 20/19 concrete and shall be suitably reinforced if necessary.

It is recommended that the casting of these foundations must be carried out by the Civil Contractor at the cost of the Contractor under this Contract in accordance with his instructions and under his supervision.

EPTM 24 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x “soft copies” of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EPTM 25 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EPTM 25.1 Design, Drawing and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. Telemetry system design shall include but limited to as listed in this Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide a complete Telemetry System design, deign drawings and wiring diagrams as specified	Sum

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| | (b) Provide operating and maintenance manuals and “as built” drawings as specified | Sum |
|--|------------------------------------------------------------------------------------|-----|

EPTM 25.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For Telemetry System, the rate tendered shall be for the complete Telemetry System and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in the Project Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site a complete Telemetry System	Sum
(b) Supply and delivery to site a complete Solar Plant	Sum

EPTM 25.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

Install of switchgear shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the switchgear complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of switchgear but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Installation to site a complete Telemetry System	Sum
(b) Installation to site a complete Solar Plant	Sum

EPTM 25.4 Commissioning

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning to site a complete Telemetry System	Sum
(b) Commissioning to site a complete Solar Plant	Sum

END OF SECTION

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

EELP EARTHING AND LIGHTNING PROTECTION

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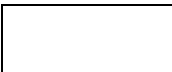
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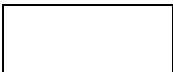
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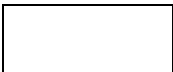
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Contractor


Witness 1


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Employer


Witness 1


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EELP EARTHING AND LIGHTNING PROTECTION

EELP 1 SCOPE OF WORKS

As specified in the project specifications.

EELP 2 STANDARDS AND TESTS

The earthing and lightning protection shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Table 5: Applicable Standards

Standard No.	Description
OHSA	Occupational Health and Safety Act
SANS 10089-1	Electrical Code for Petroleum Industry
SANS 10121	Cathodic Protection of Buried and Submerged Structures
SANS 10123	The Control of Undesirable Static Electricity
SANS 10142	Code of Practice for the wiring of Premises
SANS 10198-12	Installation of Earthing System
SANS 10199	Design and installation of an Earth Electrode
SANS 10199	The Design and Installation of an Earth Electrode
SANS 10200	Neutral Earthing in Medium Voltage Industrial Power Systems
SANS 10292	Earthing of Low Voltage (LV) distribution systems
SANS 10313	The protection of structures against lightning
SANS 1063	Earth rods and Couplers
SANS 1063	Earth Rods and Couplers
SANS IEC 61000-5-2	Electromagnetic Compatibility (EMC) Part 5: Installation and mitigation guidelines Section 2: Earthing and Cabling
SANS IEC 61024-1	Protection of Structures against Lightning Part 1: General principles
SANS IEC 61024-2	Protection of Structures against Lightning Part 2: Risk Management
SANS IEC 61024-3	Protection of Structures against Lightning Part 3: Physical damage to structures and life hazard
SANS IEC 61024-4	Protection of Structures against Lightning Part 4: Electrical and electronic systems within structures
SANS IEC 61312-1	Protection against Lightning Electromagnetic Impulse Part 1: General principles
SANS IEC 61312-4	Protection against Lightning Electromagnetic Impulse Part 4: Protection of Equipment in existing structures
SANS IEC 61643-1	Surge Protective Devices Connected to Low Voltage Power Distribution Systems Part 1: Performance requirements and testing methods
SANS IEC TS 61312-2	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

SANS IEC TS 61312-2	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing
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The lightning protection system shall be designed to protect lives and property from the destructive effects of lightning. The lightning designer shall assess corrosion effects of the lightning protection system and design accordingly.

The installation shall satisfy the requirements of all relevant South African Statutory Regulations.

Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

EELP 3 GENERAL REQUIREMENTS

Equipment and materials to be used, shall be of high quality, and shall comply with all relevant specifications, codes as mentioned in this particular specification as well as the Occupational Health and Safety Act of 1993(Act 85 of 1993).

Where equipment and material does not comply with the relevant particular specifications it shall be submitted to Engineer for approval before installation.

All materials used for the earthing and lightning protection system shall withstand the electric and electromagnetic effects of lightning current and predictable stresses without being damaged.

Materials and sizes shall be chosen bearing in mind the possibility of corrosion of either the earthing and lightning protection system or the structure to be protected.

The installation shall be in accordance with SANS 10313: Code of Practice for the protection of structures against lightning and the requirements of this specification.

All equipment and material shall comply with the relevant National and International standard standards as listed in the specification. Where equipment does not comply it shall be submitted to the Engineer for approval.

The system of protection will be finials/air terminals, down conductors and earth spike or roof conductors, down conductors and earth spike.

EELP 4 OPERATING CONDITIONS

All material and equipment supplied and fitted must be designed and manufactured for successful operation under the prevailing environmental conditions.

<div></div> <div>Contractor</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>	<div></div> <div>Employer</div>	<div></div> <div>Witness 1</div>	<div></div> <div>Witness 2</div>
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EELP 5 GENERAL PRINCIPLES

Evaluation of Risk: The risk of lightning strike shall be evaluated as described in SANS 10313 and SANS IEC 61024-2.

Effective height of a structure: The effective height of the highest point shall be determined by considering the average height of building, trees and structures and land profile of the surrounding area.

Ground flash density (Ng): The ground flash density (Ng) for general buildings, structures and installations shall be estimated from the average ground flash density given in Annexure C of SANS 10313 as a general guide.

EELP 6 AIR-TERMINATION SYSTEM

The air-termination system should be composed of any combination of the following elements:

- Rods;
- Stretched wires;
- Meshed conductors.

For the design of the air-termination system the following methods should be used:

- Protective angle method
- Rolling sphere method
- Mesh size method

The air-termination system shall be designed and installed in accordance with all the relevant SABS / SANS / IEC standards as mentioned in this document.

EELP 7 LIGHTING PROTECTION SYSTEM

The requirement of the SANS 62305-3 shall comply for the system. The lighting protection system earthing shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1.

EELP 8 EXTERNAL LIGHTNING PROTECTION SYSTEM

The requirement of the SANS 62305-3 and SANS 10313 shall comply for the system. Earth electrodes shall be designed in accordance with SANS 10199.

EELP 8.1 General

External down-conductors shall be installed between the air-termination system and the earth termination system.

The average distance between the down-conductors shall comply with SANS IEC 62305-3.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Down-conductors shall be uniformly placed along the perimeter of the structure and with a symmetric configuration. Down-conductors shall be arranged in such a way that from the point of strike to earth several parallel current paths exist and the length of the current paths is kept to a minimum. The formation of loops shall be avoided.

In order to reduce the probability of damage due to lightning current flowing in the lightning protection system, the down-conductors shall be arranged in such a way that from the point of strike to earth:

- a) several parallel current paths exist;
- b) the length of the current paths is kept to a minimum;
- c) equipotential bonding to conducting parts of the structure is performed according to the requirements

The down-conductor system shall be designed and installed in accordance with all the relevant SABS standards as mentioned in this document.

EELP 8.2 Construction

The down-conductors shall be installed so that, as far as practicable, they form a direct continuation of the air-termination conductors. Down-conductors shall be installed straight and vertical such that they provide the shortest and most direct path to earth.

Down-conductors shall not be installed in gutters or down-spouts even if they are covered by insulating material.

Down-conductors of a lightning protection system not isolated from the structure to be protected may be installed as follows:

- a) wall is made of non-combustible material, the down-conductors may be positioned on the surface or in the wall;
- b) wall is made of readily-combustible material the down-conductors may be positioned on the surface of the wall, provided that their temperature rise due to the passage of lightning current is not dangerous for the material of the wall;
- c) wall is made of readily-combustible material and the temperature rise of down conductors is dangerous, the down-conductors shall be placed in such a way that the distance between them and the wall is always greater than 0,1 m. Mounting brackets may be in contact with the wall.

When the distance from down-conductor to a combustible material cannot be assured, the cross-section of the conductor shall be not less than 100mm².

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EELP 8.3 Natural components

The following parts of the structure should be considered as natural down-conductors:

- a) The metal installations provided that:

The electrical continuity between the various parts is made durable in accordance with SANS 62305-3.

Their dimensions are at least equal to that specified in SANS 62305-3 for standard down conductors.

- a) the metal of the electrically-continuous reinforced concrete framework of the structure;
- b) the interconnected steel framework of the structure;
- c) the facade elements, profile rails and metallic sub-constructions of facades, provided that

Dimensions conform to the requirements for down-conductors shall be as SANS 62305-3 and that for metal sheets or metal pipes thicknesses shall be not less than 0,5mm.

Electrical continuity in a vertical direction conforms to the requirements of the SANS 62305-3.

EELP 8.4 Test Joints

At the connection of the earth termination, a test joint should be fitted on each down conductor, except in the case of natural down-conductors combined with foundation earth electrodes. For measuring purposes, the joint shall be capable of being opened with the aid of a tool. In normal use it shall remain closed.

The joint should be capable of being opened with the aid of a tool for measuring purposes, but normally it should be closed.

EELP 9 INTERNAL & EXTERNAL LIGHTNING PROTECTION SYSTEM

The SANS 62305-3 shall apply. For the protection against over-voltages of internal systems, see SANS 62305-4.

EELP 10 EARTH-TERMINATION SYSTEM

The design shall cater for the dispersion of the lightning current into the ground, whilst minimizing any potentially dangerous over-voltages, the shape and dimensions of the earth-termination system are the important criteria.

The lightning protection system earthing shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1. **ALL EARTHING AND BONDING ABOVE GROUND SHALL BE DONE WITH KWENA-ANTI THEFT CABLE.**

The requirements of SANS 62305-3 apply with the additions given in 10.2 and 10.3. Earth rods shall comply with the requirements of SANS 1063, and earth electrodes shall be installed in accordance with the requirements of SANS 10199. Specific attention is drawn to the requirements for explosive manufacturing and storage areas.

ALL EARTHING AND BONDING ABOVE GROUND SHALL BE KWENA ANTI-All earthing and Bonding may it be above ground.

EELP 10.1 Earth Resistivity and Electrode

Necessary earth resistivity tests on site, and invite to the Engineer for inspections must be arranged. Tests will be in accordance with the requirements of BS 1013.

After all earth electrodes/trench earth's have been installed, an earth megger shall be used to test the earth resistance at the earth bar or connection point to the main station earth and the results recorded. Note that all ECC connections, and any other bonding material shall be disconnected from the earth connection point whilst the earth is being tested.

The following are the maximum acceptable earth electrode resistances: Electrical Earth

- a) Main substation - 1 ohm
- b) Buildings Ring Earth - 1 ohm
- c) Transformer Yard - - 1 ohm
- d) Miniature substations and kiosks - 1 ohm
- e) High masts - 5 ohms
- f) Instrument Earth - < 1 ohm

EELP 10.2 Type B Arrangement

Type B arrangement as per SANS IEC 62305-3 shall be used.

Ring conductor external to the structure which will be in contact with the soil for at least 100% of its total length, or a foundation earth electrode. Earth electrodes may also be meshed.

The number of electrodes shall not less than the number of the down-conductors, with a minimum of two.

EELP 10.3 Installation of earth electrodes

The embedded depth and the type of earth electrodes shall be such as to minimize the effects of corrosion, soil drying and freezing and thereby stabilize the conventional earth resistance.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The requirements of SANS 62305-3 apply with the additions given in 10.2 and 10.3.
Earth rods shall comply with the requirements of SANS 1063, and earth electrodes shall be installed in accordance with the requirements of SANS 10199.

EELP 11 COMPONENTS

Components of a lighting protection system shall be manufactured from the materials listed in SANS IEC 62305-3 or from other materials with equivalent mechanical, electrical and chemical (corrosion) performance characteristics.

Earth electrodes shall be designed in accordance with SANS 10199.

EELP 11.1 Fixing

Air-terminations and down-conductors shall be firmly fixed so that the electrodynamic or accidental mechanical forces will not cause conductors to break or loosen as per SANS IEC 62305-1.

EELP 11.2 Connections

The number of connections along the conductors shall be kept to a minimum. Connections shall be made secure by such means as brazing, welding, clamping, crimping, seaming, screwing or bolting. Connections of steelwork within reinforced concrete structures shall conform to SANS IEC 62305-3.

EELP 12 EQUIPOTENTIAL BONDING

Equipotentialization shall be achieved by interconnecting the lightning protection with all structural metal parts, all below indicated but limited to the following:

- a) metal installations,
- b) internal systems,
- c) external conductive parts and lines connected to the structure.

Have a nominal cross-sectional area of at least 2,5 mm² copper or equivalent for indoor, and outdoor shall be aluminium, the conductors will be either cast in to the concrete or shall be so arranged that it cannot be tampered with.

EELP 12.1 Lightning equipotential bonding for external conductive parts

For external conductive parts, lightning equipotential bonding shall be established as near as possible to the point of entry into the structure to be protected.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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Bonding conductors shall be capable of withstanding the lightning current flowing through them evaluated in accordance SANS IEC 62305-1 and SANS 10142.

The requirements of SANS 62305-3 and SANS 10142 shall apply. For the protection against over-voltages of internal systems, see SANS 62305-4.

EELP 12.2 Lightning equipotential bonding for internal systems

Lightning equipotential bonding shall be installed strictly according to SANS 10313, SANS 10142 and SANS IEC 62305-3.

EELP 12.3 Lightning equipotential bonding for lines connected to the structure to be protected

Lightning equipotential bonding for electrical and telecommunication lines shall be installed in accordance with 6.2.3 of SANS IEC 62305-3.

EELP 13 TOUCH AND STEP VOLTAGES

The requirements of SANS 62305-3 apply.

EELP 14 RISK MANAGEMENT

The requirements of SANS 62305-2 apply. The Contractor shall allow for the purchase of the spreadsheet-based risk calculator which has been developed by IEC TC 81 (see annex E in SANS 62305-2:2011). The software program can be purchased directly from the IEC and shall be submitted as proof of design.

EELP 15 MAST PROTECTION FOR THATCHED ROOFS

The requirements of SANS 62305-3 shall apply with the additions given in 11.2 to 11.7. Metals used in the construction of a thatched roof shall be bonded and earthed. Water pipes, vent pipes, tanks, gas pipes, antennas, telephone and bell wires, burglar alarms and electrical wiring and conduit within 1 000 mm of the thatch shall be shielded, bonded and earthed as per SANS 10142-1.

EELP 15.1 Dangerous Sparking

Dangerous sparking between an lightning protection system and a metal, an electrical or a telecommunication installation can be mitigated which is detailed SANS 62305-3.

EELP 15.2 Ageing of thatch

Ageing of the thatch, flammable gases could evolve within the thatch and the thatch could ignite.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EELP 15.3 Metals in or on the thatch

The requirements of SANS 62305-3 shall apply.

EELP 15.4 Protection by masts

At least lightning protection level III (see SANS 62305-3) shall apply in the case of thatched structures.

EELP 15.5 Earthing of masts

All free-standing masts shall be earthed in accordance SANS 10199, and shall comply with SANS 62305-3.

EELP 16 STRUCTURES WITH EXPLOSIVE OR FLAMMABLE SUBSTANCES

The requirements of SANS 62305-3 apply with the additions given in 12.2 and 12.3.

EELP 17 DESIGN REQUIREMENTS

The requirements of SANS 62305-3 and SANS 10313 shall apply.

EELP 18 INSPECTION OF LIGHTING PROTECTION SYSTEM

The requirements of SANS 62305-3 apply and all required forms shall be in place for Engineers inspection. An Installation safety report see annex A of SANS 10313 shall be issued in respect of an inspected and compliant lighting protection system by the lighting protection system designer and installer.

EELP 19 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EELP 20 EARTH BAR

A copper earth bar shall be provided and mounted not less than 40mm from the wall or fixed structure approximately 1000mm above the final floor level and final position will be confirmed with Engineer in the position as indicated on the drawings and agreed on site. The mounting shall be electrically insulated from the wall.

A solid 200 mm x 30 mm x 5mm copper earth bar shall be provided. The earth bar shall be provided with 6 x 6mm holes evenly spaced along the entire length. 6 mm ϕ cadmium plated high tensile steel bolts complete with nuts and lock-washers shall be provided for each hole. Serrated washers shall not be used between the copper earth bar and the lug.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The earth bar shall be connected with a 70mm² Kwena Anti-Theft conductor to the building earth-termination system (system earth mat) and the tenderer shall allow for 100m of Kwena Conductor to the earth bar for tender purpose.

EELP 21 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer /Contractor shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

- a) Earthing and Lightning Protection drawings.
- b) Multiview Projections including elevations showing dimensional information including details such as, but not limited to, the following:
 - Front views
 - Side views
 - Rear view
 - Floor plan view
 - Roof view

All drawings will be obtainable from the Engineer.

- a) Structure descriptions which will be indicated on Multiview protections and elevations showing the following:
 - All Bonding
 - All Earthing and Lightning Protection equipment.
 - Earth Mat locations
 - Conductor Network
 - Fixings
 - Air terminals
 - Conductor Joint clamps
 - Earth Electrode Positions
 - Earth Inspection Pits
 - Other information as required for approval
- b) Conduit locations
- c) Unit descriptions including information such as, clamps, conductor sizes, earth electrode depth, earth inspection pits all as mentioned above (item c).
- d) Design and manufacturer Engineers approved drawings shall be provided to the Engineer in PDF format.
- e) Data sheets and publications on all major components including, but not limited to, the following:
 - Aluminium Conductor
 - KWENA Bonding Conductors
 - Clamps
 - Control power transformers
 - Pilot devices

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout / as built.

EELP 22 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EELP 22.1 Design, Drawings and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. Earthing and Lightning Protection System installation, design information shall include, but limited to, the following:

- Manufacturer's product data of lightning protection and earthing and all related components.
- Dimensioned and Professional Engineer signed drawings of lightning and earthing system showing accurately scaled basic units including, but not necessarily limited to, auxiliary compartments, unit components and combination units all as specified under this specification.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide design drawings and design information for Earthing and Lightning Protection System	Sum
(b) Provide operating and maintenance manuals and “as built” drawings as specified	Sum
(c) Provide risk management calculations and IEC Program as specified	Sum

EELP 22.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For miniature substation, the rate tendered shall be for the complete miniature substation and shall include, but not limited to, the detailed in this particular specification. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2 .

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of lightning protection system complete as specified	Each

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Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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| (b) | Supply and delivery suitable earth-termination system, earthing and earth mat as specified | Sum |
| (c) | Supply and delivery suitable earth bar as specified | Each |
| (d) | Supply and delivery all connection points, terminals, interconnections, bonding points and test joints for the entire system including for “natural” components; | Sum |

EELP 22.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning.

Install of earthing and lightning protection system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the earthing and lightning protection system complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of earthing and lightning protection system but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(a) Site installation of lightning protection system complete as specified	Each
(b) Site installation of suitable earth-termination system (system earth mat) and earth mat as specified	Sum
(c) Site installation of suitable earth bar as specified	Each
(d) Site installation of all connection Points, terminals, interconnections, bonding points and test joints for the entire system including for “natural” components;	Sum
(e) Earthing resistance survey upon completion of the excavations and test report	Sum

EELP 22.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, testing apparatus, instruments and equipment, any/all equipment required for testing purposes and to prove performance, any/all temporary works, and compilation of final commissioning report.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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Contractor shall submit three copies to the Engineer. Contractor shall notify the Engineer one week in advance of the test so that the Engineer may be present.

<u>Pay Item</u>	Unit
(a) Commissioning of complete lightning protection system, inclusive of down conductor, earth-mat and earth spikes, etc.	Sum
(c) Certificate of compliance of lightning protection system	Sum

END OF SECTION



RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

**ESPL SMALL POWER AND LIGHTING INSTALLATIONS ON BUILDINGS
AND STRUCTURES**

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ESPL SMALL POWER AND LIGHTING INSTALLATIONS ON BUILDINGS AND STRUCTURES

ESPL 1 SCOPE OF WORKS

As specified in the Project Specifications.

ESPL 2 STANDARDS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Table 6: Applicable Standards

Standard No.	Description
BS 3676	Switches for household and similar fixed electrical installations. Specification for general requirements
SANS 156	Moulded-Case Circuit Breakers
SANS 164	Plug and socket-outlet systems for household and similar purposes for use in South Africa
SANS 201	Energy Efficiency in Buildings
SANS 474	Code of practice for electricity metering
SANS 475	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
SANS 890	Ballasts for fluorescent lamps
SANS 950	Un-plasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations
SANS 1012	Electric light dimmers
SANS 1085	Wall boxes for the enclosure of electrical accessories
SANS 1091	National colour standard
SANS 1195	Bus bars
SANS 1213	Mechanical cable glands
SANS 1239	Plugs, socket-outlets and couplers for industrial purposes
SANS 1411	Materials of insulated electric cables and flexible cords
SANS 1619	Small power distribution units (ready boards) for single-phase 230V service connections
SANS 1765	Machine-made textile floor coverings - Determination of thickness
SANS 1777	Photoelectric control units for lighting (PECUs)
SANS 10142	Code of Practice for the wiring of Premises
SANS 10114-1	Interior lighting Part 1: Artificial lighting of interiors
SANS 10114-2	Interior lighting Part 2: Emergency lighting
SANS 60309-1	Plugs, socket-outlets and couplers for industrial purposes Part 1: General requirements
SANS 60309-2	Plugs, socket-outlets and couplers for industrial purposes Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories
SANS 60570	Electrical supply track systems for luminaires
SANS 60669-1	Switches for household and similar fixed-electrical installations Part 1: General requirements
SANS 60669-2-1	Switches for household and similar fixed electrical installations Part 2-1: Particular requirements - Electronic switches

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Standard No.	Description
SANS 60669-2-2	Switches for household and similar fixed electrical installations Part 2-2: Particular requirements - Electromagnetic remote-control switches (RCS)
SANS 60669-2-3	Switches for household and similar fixed electrical installations Part 2-3: Particular requirements - Time-delay switches (TDS)
SANS 60669-2-4	Switches for household and similar fixed electrical installations Part 2-4: Particular requirements - Isolating switches
SANS 60669-2-5	Switches for household and similar fixed electrical installations Part 2-5: Particular requirements - Switches and related accessories for use in home and building electronic systems (HBES)
SANS 60906-3	IEC system of plugs and socket-outlets for household and similar purposes Part 3: SELV plugs and socket-outlets, 16 A 6 V, 12 V, 24 V, 48 V, a.c and d.c
SANS 60921	Ballasts for tubular fluorescent lamps - Performance requirements
SANS 60947-1	Low-voltage switchgear and control gear Part 1: General rules
SANS 60947-2	Low-voltage switchgear and control gear Part 2: Circuit-breakers
SANS 60947-3	Low-voltage switchgear and control gear Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
SANS 61084-All	Cable trunking and ducting for electrical installations
SANS 61347-All	Lamp control gear Part
SANS 10292	Earthing of low-voltage (LV) distribution systems

ESPL 3 SPL CABLING AND ACCESSORIES

ESPL 3.1 PVC Insulated Conductors

PVC insulated conductors shall be of high conductivity, stranded copper with Polyvinyl Chloride insulation of 600/1 000 volt grade.

The wiring of circuits shall be carried out on the "loop-in" system and no jointing of conductors in conduit runs or cutting away of wire strands will be permissible.

Connectors for use in conduit boxes shall be of the heavy brass terminal type mounted in porcelain insulators.

All plug circuits shall consist of 2 x 4mm² PVC insulated conductors plus 1 x 2,5mm² bare copper earth wire in Ø20mm conduit.

All lighting circuits shall consist of 1,5mm² PVC insulated conductors in 20mm conduit. For fluorescent lights an additional 2,5mm² bare copper earth wire shall be provided and thoroughly bonded to each fitting.

Connections between lamp holders of incandescent fittings and the conduit boxes shall consist of asbestos insulated wire or other approved heat resistant conductors.

ESPL 3.2 Conduit And Conduit Accessories

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Conduit, conduit accessories and conduit fittings shall be hot-dip galvanized both on the inside and outside

Only brass bushes and bush nuts will be acceptable.

The conduit installation shall be carried out on the "loop-in" system and no conduit shall have a diameter of less than 20 mm. All conduits shall be built into walls, concrete ceilings etc., and no conduit will be allowed on the surface.

All conduit ends shall be remerged and all joints securely screwed together. No inspection bends or elbows will be allowed in the installation. Running joints may only be used where unavoidable and shall be provided with lock nuts. All screwed joints shall be thoroughly painted with "Red Lead" in order to prevent corrosion.

No conductor may be drawn into any conduit, unless all foreign materials, moisture and sharp edges have been removed.

In event of a conduit terminating in any sheet metal box, two lock nuts and a brass bush or one lock nut and a bush-nut shall be used.

Standard round conduit boxes shall be used for light points and draw boxes. Draw boxes shall be provided with enamelled metal cover plates with brass screws.

Standard 100 x 50 x 50 mm hot dipped galvanised pressed steel boxes shall be used for all switch boxes.

Standard 100 x 100 x 50 mm hot-dipped galvanised pressed steel boxes shall be used for all plug boxes and telephone outlets.

Expansion boxes shall be provided at all expansion joints in the building. Such expansion box shall comprise a flush hot dipped galvanised sheet steel box with blank enamelled steel cover plate secured in position by means of brass screws. The conduit on the one side shall be securely fixed to the box, while the conduit on the other side shall be able to move freely in the box in order to provide for movement of the building. The conduit on the one side shall be bonded to that on the other side inside the box by means of flexible copper connections with clamps, bolts and nuts, in order to ensure earth continuity.

The conduit shall be installed in the concrete ceilings along the shortest possible routes, with the cover plates of draw boxes on the final ceiling surface. Conduit shall be installed as near as possible to the neutral axis of concrete beams, slabs and columns and deep conduit boxes shall be used.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All unwired conduits should be equipped with hot dipped galvanised draw wires with at least 200 mm ends on each end of the conduit. The ends of the draw wire shall be neatly coiled in the draw boxes.

ESPL 3.3 Standard 100 X 100 X 50 mm And 100 X 50 X 50 mm Boxes

The above mentioned boxes shall be heavy gauge, hot-dip galvanized, pressed steel boxes.

ESPL 3.4 Cover Plates

All cover plates (switch boxes, plug boxes and draw boxes) should be of baked enamelled steel. The colour to be approval by the Engineer, with input for the Architect and Client.

ESPL 4 LIGHTING INSTALLATIONS

ESPL 4.1 Light Switches

Light switches shall comply with SANS 10142 and BS 3676.

Standard mounting box for all light switches: 100 x 50 x 50mm, hot dip galvanized and neat rounded corners

Light switches current rating: >16Amp and suitable for the load it is connected to.

Flush mounted switches: micro type with white rocking lever

Watertight switches to be installed in cast iron boxes, inclusive of watertight cover plates and clearly marked with "ON" and "OFF" positions.

The switch lever shall be protected where it protrudes through the cover plate.

ESPL 4.2 Light Fittings

Light fittings shall be of the latest technology lamps and control equipment as prescribed. LED lights shall be installed as specified.

Fluorescent light fittings shall be equipped with electronic ballasts.

Fluorescent lamps colour temperature: 3 000°K unless otherwise specified.

Light fittings with filament lamps installations: wiring between the terminal box and the lamp holder shall have heat resisting insulation.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESPL 4.3 Insect Killers

As specified in the project specifications.

ESPL 5 SMALL POWER INSTALLATIONS

ESPL 5.1 Power Outlets

Plug outlets shall be of the combined 3 pin, 13Amp or 16Amp socket and switch combination.

Type: flush mounted units, with a white rocking lever.

Mounting box: 100 mm x 100 mm x 50 mm and neat rounded corners.

The switch lever shall be protected where it protrudes through the cover plate.

ESPL 5.2 Three Phase And Multi-Pin Plug Outlets

Three phase plug outlets shall be either;

- 63A, 400V, 5 pin units complete with plug and interlocked isolating switch; or
- 32A, 400V, 7 pin units complete with plug and interlocked isolating switch.

ESPL 5.2.1 Isolator Installation

Isolation installation: 100x50x50mm, IP 65 weatherproof wall box as indicated on the drawings, as required.

Isolators shall be one of the following and as specified;

- 20A double pole;
- 30A double pole;
- 60A double pole;
- 30A triple pole; or
- 60A triple pole.

Mounting height (kitchens and other areas where cupboards are fitted): 1050 mm AFFL

Mounting height (gate motors): 500mm AFFL

Isolator units to be installed in an accessible location and in close proximity to the particular equipment (ex. air-conditioning units, geysers, extractor fans, gate motors, etc.) and as indicated on the drawings.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ESPL 6 DISTRIBUTION BOARDS

Each of the relevant distribution boards shall be built into walls or securely bolted down on the floor or plinth by means of the requisite number of foundation bolts grouted into the floor in the positions indicated on the drawings.

These positions shall be confirmed with the Engineer on site prior to installation as follows;

- a. Contractor shall install distribution board in accordance with manufacturer's instructions.
- b. Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer's torque requirements.
- c. Contractor shall select and install fuses in fusible switches based upon field requirements.
- d. Contractor shall adjust circuit breaker settings based upon field requirements.
- e. Contractor shall adjust solid state overloads to match the installed motor characteristics.

ESPL 6.1 Wall Surface Mounted Type Mounted Lv Db Specifications

DB board type:

- Surface mounted with doors, 1,6 mm sheet steel, with a bonding tray, chassis and removable panel.

Bonding trays:

- Adequately sized in order that all the relevant equipment is installed without cramping and adequately braced with suitable gaskets.

DB Doors:

- Secured with robust and rust proofed hinges. A single door shall not be wider than 600 mm.
- Rust proofed handles and latches. Ball type batches will not be acceptable.

DB chassis:

- Rigid and facilities shall be provided on the chassis for mounting all the relevant equipment.

Mounted:

- Panels shall be mounted in order that all equipment are flush behind the panel with only operating handles and push buttons projecting through neat machine punched slots in the panel.
- Panels shall be provided with chromium plated brass handles to facilitate removal.
- The panel shall be rigid and readily removable without necessitating the disturbance of any of the equipment on the board.

Colouring:

- Interior surfaces of the board shall be powder coated white .
- Exterior surfaces (including panels) in colour B26, SANS 1091 (Electric orange).

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Powder coating shall be of the best quality with high shock and scratch resistance.
- Before powder coating, metal parts shall be thoroughly degreased and cleaned by shot blasting to be free of rust, mill-scale and other foreign materials.

Gland Plate:

- A 3CR12 steel gland
- Fitted to the bottom section of the board to facilitate termination of cables by means of cable glands.

Busbars:

- Shall consist of tinned solid high conductivity copper mounted on suitable busbar insulators.
- Connections to busbars shall be done with suitable lugs sweated or crimped to the conductor ends, and cadmium plated high tensile steel bolts, nuts and washers.

Copper multiway neutral and earth bars:

- Shall be equipped with cadmium plated high tensile steel bolts, nuts and washers for connection of the various conductors.
- The neutral bar shall be mounted on busbar insulators, but the earth bar shall be thoroughly bonded to the metalwork of the board.

The internal wiring of the boards:

- Done with PVC insulated conductors arranged neatly horizontally, vertically and at right angles in front of the chassis.
- The conductors shall be neatly bunched by means of cable ties. (String will not be acceptable.)

Labelling:

- An engraved plastic label of the black on white sandwich type shall be screwed to the panel below each item of equipment.
- For single pole equipment a number system shall be used.
- A neatly typed legend card behind clear "Perspex" in a metal frame should be provided. The frame shall be mounted on the inside of the switchboard doors.

Sundries:

- All bolts, nuts, washers and screws used on should be rustproof.
- The use of self-tapping screws will not be allowed.

ESPL 6.2 Wall Flush or Semi-flush mounted DB Specifications

Flush and semi-flush mounted distribution boards shall be manufactured as follows;

- Constructed of 1,2mm sheet steel (minimum) and shall comply with SANS 1180 Part 1.
- Including rust hot dipped galvanised wall tray.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Braced with of suitable gussets.
- Suitable sized to accommodate equipment without cramping as specified in the schedules.
- Expanded metal to be spot-welded at the rear of all wall trays for 110mm walls.
- Formed with bevelled or flat edges and neatly mitred and shall accommodate the panel chassis and door/s.
- The lip for the mounting of the circuit breaker carriers, and front panels shall form part of the architrave frame.

Panels Door specifications:

- Rigid and manufactured with a smooth flat finish.
- Suitably braced to ensure stiffness,
- Recessed flush in the architrave.
- Door catches shall be equal and similar to "Union" manufacture, as follows;
 - Cat No. 51741 (solid, no lock), or
 - Cat No. 5174 (with built-in lock),
- Single doors to be constructed of sheet steel and shall open at least 150 degrees.
- The distance between panel and inside of door(s) shall be not less than 40mm.
- Circuit breaker carriers specifications;
- Rigid construction for mounting of equipment.
- Fixed to the architrave frame and provided with the necessary means for fixing of circuit breakers, isolators, etc.
- Width of carriers for compact circuit breakers shall be such that a distance of 10mm is maintained between the carriers.

Mounted:

- Panels shall be mounted in order that all equipment are flush behind the panel with only operating handles and push buttons projecting through neat machine punched slots in the panel.
- Panels shall be provided with chromium plated brass handles to facilitate removal.
- The panel shall be rigid and readily removable without necessitating the disturbance of any of the equipment on the board.
- Panels shall be attached to architrave by means of captive fasteners (with screw driver slots).
- Self-tapping screws are not acceptable.
- Panels can also be fitted by means of two guiding pins at the bottom or on the hinge side of the door.

Slots for equipment:

- Slots for equipment installed separately shall have the exact dimensions to accommodate only the specific equipment, as per example main switches, earth leakage relays, etc.
- A maximum tolerance of approximately + 1mm shall be maintained on all sides between slots and equipment.
- Power meters:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Where required, power meters shall also be flush mounted behind the panels and Contractors are required to co-operate with the supply Authorities in this respect.

Busbars specifications:

- Consist of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 1195 for each phase and neutral and are to be installed in a group in the top section of all distribution boards.
- Busbars to be installed either horizontally or vertically.
- Busbars must be so arranged that horizontal bars are placed one above the other and vertical bars placed side-by-side, with the flat surface facing front wards to facilitate connections and clear of all equipment.
- Where necessary, busbars shall either be twisted to a 45° angle or shall be stepped in the horizontal plane.
- 50mm spacing between bars to be provided.
- A set of busbars should be installed in each section of a distribution board feeding more than two three phase connections including future equipment.
- These busbars shall not be mounted directly onto the terminals of any triple pole circuit breakers, fuse-switches or isolators.
- Busbars shall be mounted on coloured "ceramic" or "paxalene" or similar insulators. Colour of insulators shall be in phase colours, red, white, blue and black for neutral.
- Busbars for single pole circuit breakers shall consist of solid copper with a minimum cross-section of 1,5mm x 19mm and shall be fixed directly to the terminals of the circuit breakers. Single pole circuit breakers should be grouped distinctly separate for the three phases, in horizontal rows (one above the other) in the following sequence, red, white and blue, starting with red on top.
- Connections to busbars shall be done with lugs, sweated or crimped to cable ends and bolted to busbars with cadmium plated 6mm diameter steel bolts (machined bolts) and nuts. Bolts shall be of the hexagonal head type, with 6mm thread and must be provided with washers, spring washers and hexagonal nuts.
- Busbars are to be drilled and tapped and bolts must be screwed into the busbars from the rear. Connection facilities to busbars shall make provision for the number of three phase connections as well as spare connections specified.
- Spare bolts, complete with washers and nuts, are to be screwed into each busbar, to allow for future extensions.
- Busbars shall be mounted on a rigid chassis and the use of two chassis for the mounting of a busbar will not be permitted. Only similar metals shall be used for busbars and connections thereto.
- Each busbar shall be provided with one large terminal for the main conductor. All busbars must be accessible from the front.

Wiring specifications;

- Wiring is to be carried out from the sides and in front of the chassis with conductors neatly arranged in horizontal, vertical and at right angles rows and bound together by means of perforated plastic tape (string will not be acceptable).

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Each conductor within the harness shall be kept parallel to the others without twisting or spiralling and shall be free of links.
- Only one conductor per connection point will be permitted
- All wiring is to be kept free and away from any exposed terminals, or other non-insulated current carrying parts.
- Looping from terminals of main switch, circuit breakers, or isolators will be limited to a maximum of only two outgoing circuits per DB, more than two circuits shall be connected to the busbars.
- Only copper conductors will be permitted.
- Internal wiring in the DBs, shall consist of stranded conductors and shall be in the colours of the relevant phases being red, white, blue and black for neutral.
- Colour taped conductors will not be permitted
- Switch boards shall be supplied completely wired and ready for connection.

DB powder coated finish specifications:

- All metal parts shall be degreased, rinsed, pickled, rinsed, phosphate, neutralized and then to be thoroughly dried.
- The above process is to be followed by the following powder coating process, before distribution boards are delivered for installation.
- Powder coating finishing shall be colour B26, SANS 1091 (Electric orange) or a colour as described by the Architect. Care to be taken that all edges are properly covered with powder coating.

Labelling:

- Screwed-on, engraved labels, of the white-on-black type, shall be provided on the front of the DB to identify the equipment and instruments as indicated on the proposed layout.
- Inscriptions shall be 6mm high lettering on Ivorene labels. Fixing screws shall be chrome or brass 6BA roundhead.
- **Note:** All grouped SP circuit-breakers on distribution boards and cubicles must be numbered with suitable engraved printed plastic or Ivorene plates indicating numbers of circuit controlled.
- A neatly typed legend card behind clear "Perspex in a metal frame shall be provided for this purpose.
- The frame shall be spot welded on the inside of the switchboards doors.

ESPL 7 ACCESSORIES FOR SWITCHBOARDS

ESPL 7.1 Mains Surge Arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures requirements. All surge arrestors shall be **connection type 2** as per the latest addition of the SANS 10142.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESPL 7.2 Building with External Lightning Protection

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

ESPL 7.3 Building With No Lightning Protection

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

ESPL 7.4 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with SANS 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.

Each circuit breaker shall be provided with non-adjustable time-delayed trips.

ESPL 7.5 Current Limiting Circuit Breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200 kA RMS at least three times.

ESPL 7.6 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "**CLASS II MECHANICAL DUTY CLASS**" and "**A3 Make and Break Category**".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

ESPL 7.7 Time Switches

The time switches shall be suitable for use on a 230 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 230V.

ESPL 7.8 Earth Leakage Units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

ESPL 8 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

Earth resistivity measurements of less than 1 ohm will be acceptable at motor control centers and distribution boards.

ESPL 9 DANGER SIGNS

Danger signs on aluminum plates shall be supplied on each door of an outdoor motor control center or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

ESPL 10 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness. The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

The cost of all tests must be included in the tender price.

ESPL 10.1 Testing Of Distribution/Motor Control Boards

Each distribution/motor control board shall be subjected to the following tests in the manufacturer's works after manufacture:

- a. A thorough inspection shall be carried out to ensure compliance with the specification and approved drawings and wiring diagrams and to ascertain that all connections are properly made.
- b. A high voltage test on all primary connections to check the insulation between phases mutually and between each phase and earth.
- c. The polarities and ratios of all potential and current transformers shall be checked.
- d. Primary and secondary injection tests shall be carried out on all switching, protection, metering interlocking and indication circuits.

The manufacturer shall submit three copies of test certificates giving details of conditions and results of tests carried out to the Engineer.

ESPL 10.2 Operating And Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x "soft copies" of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESPL 11 SUPPORTING DOCUMENTATION

ESPL 11.1 Information to Be Submitted With Tenders: 400v Db

Before manufacturing, the following information shall be submitted with each Tender in respect of all boards offered;

- a. Full technical details and descriptive literature regarding all equipment and instruments offered;
- b. Three paper prints of an outline drawing of each motor control centre and distribution board indicating the main overall dimensions and general lay-out of the boards; and
- c. Three paper prints of an outline drawing of the front end processor cabinet indicating the main overall dimensions, general layout and type of material employed on the face of the panel.

ESPL 11.2 Information Required With Tender Submission

The following information regarding the switch- and distribution boards shall be submitted with each tender.

- a. The name and address of the switchboard manufacture.
- b. Descriptive literature and technical information of all equipment and instruments offered with the boards.
- c. Wiring diagrams of all distribution boards.
- d. Schematic single line diagrams of all distribution boards.
- e. Elevations showing dimensional information including details such as, but not limited to, the following:
 - Distribution boards height (less any removable lifting angles or eyes)
 - Distribution boards width
 - Distribution boards depth
 - Location of shipping splits
- f. Structure descriptions showing the following:
 - Bus ratings
 - Enclosure ratings
 - Short-circuit withstand ratings
 - Other information as required for approval
- g. Conduit locations
- h. Required bus splices
- i. Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous ampere ratings, and pilot devices
- j. Nameplate information
- k. Manufacturer drawings shall be provided in PDF format
- l. Data sheets and publications on all major components including, but not limited to, the following:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Motor starters
- Overload relays
- Circuit breaker and fuse information including time current characteristics
- Control power transformers
- Pilot devices
- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

ESPL 11.3 As Built Information

On completion of the works, but before the certificate of completion will be issued, the contractor shall submit to the Engineer, as built information in electronic format indicating in a satisfactory manner:

- a) The exact position of all electrical installation equipment in the buildings
- b) Distribution board as built wiring diagrams
- c) Certificate of Compliance for all building installations

Electronic copies of the various plans for the marking up of the information required will be supplied to the contractor on request.

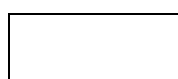
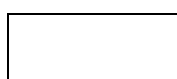
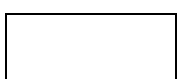
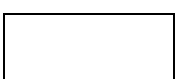
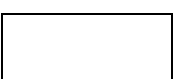
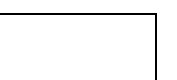
ESPL 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

ESPL 12.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For distribution board's installation, design information shall include, but limited to as listed in this Particular Specifications.

<u>Pay Item</u>	<u>Unit</u>
(a) Provide design drawings and wiring diagrams as specified	Sum
(b) Provide operating and maintenance manuals and "as built" drawings as specified	Sum
(c) Allowance for short circuit analysis and coordination study and protection setting calculations	Sum

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



ESPL 12.2 Supply And Delivery To Site

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of complete electrical installation equipment as specified	Sum

ESPL 12.3 Installation

<u>Pay Item</u>	<u>Unit</u>
(a) Installation of complete electrical installation as specified	Sum

ESPL 12.4 Commissioning

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of complete electrical installation as specified	Sum

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS

EMCA MULTICORE CABLES AND EARTHWIRES

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

EMCA MULTICORE CABLES AND EARTHWIRES

EMCA 1 SCOPE OF WORKS

As specified in project specifications

EMCA 2 STANDARDS AND TESTS

Cables shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply:

Standard No.	Description
SANS 97	Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV
SANS 1339	Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1713	Electric cables - Medium-voltage aerial bundled conductors for voltages from 3,8/6,6 kV to 19/33 kV
SANS 10142	Code of Practice for the wiring of Premises
ITU-T G.651.1	Design of the multimode Fibre Optic network

EMCA 3 CONSTRUCTION DETAILS

EMCA 3.1 Low Voltage Cables

All multi core cables shall be stranded metal annealed copper conductor, PVC insulated, PVC bedded, single wire armoured and PVC sheathed in accordance with SANS 1507 as amended to date for cables with copper conductors and insulated for 500/3300 volt grade.

Cables for status and analogue signals shall consist of the requisite size and number of copper twisted pairs, individually and overall screened, PVC sheathed, steel wire armoured and PVC covered, complying with the requirements of SANS 1507 where applicable.

Cables and earth wires for a specific application shall be selected strictly in accordance with the requirements laid down in SANS 10142 in respect of current rating and voltage drop. Where practicable the earth continuity conductor shall form an integral part of the cable.

EMCA 3.2 Medium Voltage Cables

These cables shall be manufactured in accordance with NRS. 013-1991 and comply with SANS 97 - 1991. All the 11 kV cables shall have copper conductors and shall be suitable for use on an unearthed system.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Three core cables shall be of the fully impregnated belted type. The cable shall have a helical fibrous bedding, lead alloy E sheath, single wire armour and a PVC serving as laid down in the Variations and Additions to the Standard and Particular Specifications, all in accordance with SANS 97 - Table 18. Single core cable shall be fully impregnated, screened general purpose cable with copper conductors suitable for an earthed system. The cables shall be in accordance with Table 11 of SANS 97, shall have a lead alloy E sheath and a PVC anti-electrolytic over sheath. (Type PEC)

EMCA 3.3 Fibre Optic Cables

EMCA 3.3.1 Communication Network (Fibre Optic Cable - Multimode)

The multimode Fibre Optic communication network shall have both uplink and downlink connections available.

EMCA 3.3.2 Technical Design Requirements

The design of the multimode Fibre Optic network shall include, amongst others the following minimum design requirements:

- a) Detailed optical power budget calculations
- b) Transceiver SFP details
- c) Fibre link lengths
- d) dB losses per each patch cord/lead used
- e) Any Mid-couplers used
- f) Type of Patch panels installed (8-way, 16-way, etc.)
- g) Type of connectors used (LC, ST, etc.)
- h) Amount of splicing joints made

The design of the multimode Fibre Optic network shall conform, amongst other international standards to the following international standard: **ITU-T G.651.1** specification.

The distances between the sites that will be interconnected will be indicated on the specific drawings and/or project specifications. The contractor shall however confirm these distances as part of their final design.

No splicing of Fibre Optic cable joints shall be allowed, except for termination of the Fibre Optic cables in the patch panels at all the respective sites. The design of the entire multimode Fibre Optic network shall be based on international standards, including but not withstanding the **ITU-T G.651.1** specification. The design shall include, amongst others the technical details specified below:

- a) **Type of SFP transceivers selected** - Shall include the following design details:
 - o Optical Power Budget (PB)
 - o Minimum Optical Power transmission values (dBm)

- Minimum Receiver sensitivity values (dBm)

b) 76

- dB losses from connectors;
- dB losses from patch cords;
- dB losses from patch panels;
- dB losses from mid-couplers;
- dB losses from pig-tails;
- dB loss/km for each specific Fibre Optic link (@ 850nm wavelength)

EMCA 3.3.3 Express/Emergency Joints

Each Fibre Optic link shall be installed without the need for any splicing joints in-between sites. Only splicing at the patch panels on either side (at both sites) is expected. Express or Emergency splicing joints shall only be done when a Fibre Optic cable has been damaged and needs to be temporarily repaired to restore service.

Before commencing with any such endeavours, the Contractor shall firstly request permission from the Engineer if the need to make an Express or Emergency splicing joint arises. The Engineer reserves the right to decline such a request from the Contractor. An express joint shall always be a temporary measure only and the repaired cable shall be replaced as soon as possible (The Contractor shall communicate the time frame on the replacement of the affecting Fibre Optic link to the Engineer).

For Information: The overall design of the Fibre Optic network shall ensure the optimal Optical Power Budget (**PB**) shall remain after installation, to cater for any such temporary Express or Emergency splicing joints, without affecting the overall Quality of Service (QoS) relevant to the Fibre Optic Link affected.

EMCA 3.3.4 Optic Fibre Optical Characteristics

The multimode Fibre Optic cable shall conform to the following **Optical** properties and characteristics:

- a) 8 cores
- b) Typical Core Diameter - 50 μm ;
- c) Cladding Diameter - 125.0 \pm 1 μm ;
- d) Primary Buffer >250 μm ;
- e) Secondary Buffer >900 μm ;
- f) Bandwidth at 850nm – 1000 MHz/km;
- g) Cable Fibre Attenuation – <5dB/km @ 850nm, <3dB/km @ 1300nm;
- h) Each Optical Fibre shall consist of a doped silica core surrounded by a concentric silica cladding;
- i) The Fibre shall be a matched clad design; and
- j) The coating shall be dual layered and UV-cured acrylate.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMCA 3.3.5 Optic Fibre Mechanical Properties

The multimode Fibre Optic cable shall conform to the following **Mechanical** properties and characteristics:

- a) The cable shall consist of a dielectric, glass reinforced plastic (GRP) rod to prevent bucking of the cable;
- b) Water-blocking technology shall be used to impede migration of water through the cable core;
- c) Fillers shall be included in the cable core to aid in symmetry of the cable cross-section if needed;
- d) A water blocking tape shall be applied longitudinally around the outside of the stranded tubes or fillers;
- e) The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and any foreign matter;
- f) High tensile strength dielectric yarns shall be helically stranded evenly around the cable core to improve tensile strength;
- g) Ripcords shall be provided in the cables for easy sheath removal;
- h) The armoured cables shall contain two ripcords under the steel armour;
- i) The armoured cable shall contain corrugated steel tape/steel wire, plastic coated on both sides for corrosion resistance;
- j) It shall be applied around the outside of the water blocking tape over the dielectric tensile strength members;
- k) This shall be done with an overlapping seam with all the corrugations in line;
- l) The outer jacket shall be applied over the corrugated steel tape/steel wire armour;
- m) The outer jacket / sheath shall be HDPE;
- n) The minimal outer jacket thickness shall be 2.0 mm;
- o) The cable jacket on the armoured cables shall contain no metal elements and shall be of a consistent thickness;
- p) The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C;
- q) The installation temperature range of the cable shall be -30°C to +70°C;
- r) Cable Sheath Marking - All cables shall have sequential length markings along the cable sheath;
- s) The height of the marking shall be approximately 2.5 mm; and
- t) As required by Section 350 G of the NESC, ANSI C2-1993, all cables shall have a visual identifier to identify them as telecommunications / data-communications cables.

EMCA 3.3.6 Fibre Optic Cable Installation Requirements

The Fibre Optic cable shall be installed in 50mm cable ducts. The requirements for the cable duct shall be as follows:

- a) Direct burial type of duct
- b) 50mm outside diameter
- c) UV rated

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- d) Pre-installed pull tape
- e) Silicone lined for reduction in friction
- f) Manufactured according to SABS ISO 9001
- g) Jointing of duct only via high compression couplings
- h) Ducts shall have a pressure rating > 9 Bar

Where the cable route changes direction (termination of fibre links into buildings, change of direction due to services and infrastructure, etc.), manholes/handholes shall be constructed or installed if of the pre-cast/polyethylene type.

The Contractor shall be required to survey the route prior to the commencement of the installation of the multimode Fibre Optic cables to determine the following:

- a) The length of the route that requires the Fibre Optic cable;
- b) The terrain conditions and terrain accessibility;
- c) Crossings including existing services, streams, rivers, pipelines, etc.;
- d) Location and condition of existing manholes (where applicable);
- e) Distances between existing manholes (where applicable);
- f) Distances between planned new manholes;
- g) Accessibility of the terrain, if the use of mechanical hauling equipment is preferred;
- h) However, the pulling in of multimode Fibre Optic cables by hand is preferred;
- i) Identification and allocation of correct spare pipe to be utilised if available;
- j) Once the above has been verified, a proper hauling schedule shall be compiled;
- k) Cables are normally available in full drum lengths from the cable supplier and it is essential to make optimum use of the available lengths;
- l) Confirm the available lengths from cable supplier before the hauling schedule is compiled;
- m) Ensure that the cables are drummed correctly to suit the direction of pull; and
- n) Drums shall be unloaded from its transport vehicle using a JCB or fork-lift truck.

EMCA 4 JOINTING OF CABLES

EMCA 4.1 Low Voltage Cables

Joints will only be allowed where more than one full drum length of cable is necessary to complete a specific circuit and must be restricted to the absolute minimum. All joints shall be made to the best practice by competent cable jointers using first class material. The contractor shall maintain the electrical continuity of the armouring in an approved manner at all straight through joints.

Heat shrinkable cable joint kits that will suit the relevant cable size shall be used for all low voltage cable joints

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMCA 4.2 Medium Voltage Cables

On 11 kV cables, straight joints shall be made by means of heat-shrinkable straight through joints for unearthed paper insulated cables up to 11 kV. All cable joint kits shall comply with NRS 053 Specifications

The joints shall be made to the manufacturer's instructions and with materials stipulated in such instructions.

The cores of the cable shall be joined colour to colour or number to number.

EMCA 4.3 Fibre Optic Cables

Joints in fibre optic cable must be avoided as far as possible due to losses in signal strength when jointed.

The joints shall be made to the manufacturer's instructions and with materials stipulated in such instructions.

EMCA 5 TERMINATION OF CABLES

EMCA 5.1 Low Voltage Cables

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double inner seals as well as waterproofing seals on nipples.

Cable armouring shall be earthed at each end but may not be used as earth continuity conductor.

EMCA 5.2 Medium Voltage Cables

Medium voltage cable terminations shall be heat shrinkable termination kits and shall comply with NRS 053 Specifications.

The cable terminations shall be made to the manufacturer's instructions and with materials stipulated in such instructions.

EMCA 5.3 Fibre Optic Cables

Fibre optic cables shall be terminated by means of suitable glands, ST connections and bus terminals capable of direct connection to the bus interfaces on the bus stations. These bus stations will be housed in separate panels of various motor control centres.

EMCA 6 CONCRETE CABLE SLABS

The cable slabs supplied and installed under this Contract shall be formed solidly out of concrete with steel reinforcing and shall have dimensions of 1 000 x 350 x 100 mm. Alternative block sizes will be considered. The following concrete mixture is desired:

- 1. Portland cement (dry) - 1 part per volume
- 2. Clean dry river sand - 3 parts per volume
- 3. Crushed stone (size 10 mm) - 6 parts per volume

EMCA 7 CABLE TRAYS AND CABLE LADDERS

Heavy duty cable trays and cable ladders manufactured from hot dipped galvanised steel or grade 304 stainless steel, as specified in the Variations and Additions to the Standard and Particular Specifications, shall be supplied and installed as indicated on the drawings. The height of the cable ladder sides shall be 76 mm with the width to suit the number and size of cables to be installed.

EMCA 8 INSTALLATION OF CABLES

EMCA 8.1 Cable Handling

NOTE - Under no circumstances shall the drums be dropped from the transport vehicle onto the ground.

Small drums can be rolled carefully to the installation point. Drums shall never be allowed to roll freely down a slope. In most instances a drum trailer or similar arrangement shall be used. Battens shall only be removed when ready for installation. When deploying cable from a rotating drum into a trench or duct, it shall be ensured that the drum stand or trailer is firmly located and that rotation of the drum during installation shall not cause any problem.

The Contractor shall ensure that the drum does not lie flat during installation and that coils are pulled off thus causing corkscrew twists. This shall be avoided at all cost as this will cause cable damage and installation problems, the replacement costs for the cable of which shall be for the contractor's account. No bends, kinks, damaged cable shall be accepted.

To minimize problems which may arise due to water/moisture contamination, the following guidelines shall be adhered to:

- a) Do not cut or break into cables until it is absolutely necessary;

- b) Before cutting into or breaking, pump out any standing water in the manhole or trench if applicable;
- c) Before cutting or breaking cable, check weather conditions and if applicable cover the manhole/trench with a tent or waterproof covering (Rain, Thundershowers, Hail, etc.);
- d) When terminating or splicing always arrange the cable working position 'above ground' so as not to allow the cables to lie on the ground or in water;
- e) If a cable end has to be created by cutting through a continuous cable, fit a waterproof sealing end cap until such time is required to open the end of the cable for termination or splicing; and
- f) If cut cables have to be left for a considerable period of time like overnight or longer, then the cable shall have to be sealed to prevent water ingress.
- g) Where patch panel are installed, the patch panels shall be earth bonded to earthing bars.
- h) The Contractor shall strictly comply to all the manufacturers recommendations, and everything shall be accordance to Aberdare Cable Facts and figures booklet. Extreme care shall be used not to damage cables as cable replacement shall be at the contractor's expense.
- i) The Contractor shall use the Aberdare Cable Facts and figures booklet to submit a detailed quality control plan and submit to Engineer for approval.

EMCA 8.2 Cable Trenches

The contractor will be responsible for the excavation, bedding, back-filling, consolidating and making good of all cable trenches along the routes indicated on the drawings, with the exception of those sections of the cable routes where it is specifically indicated on the accompanying drawings that open cable ducts will be provided by others. The Contractor however will be responsible for the bedding and filling soil in cable ducts where necessary. A sealing screed to cover the cable duct shall be provided by others unless otherwise stated in the Variations and Additions to the Standard and Particular Specifications and relevant drawings.

The Contractor may need to adjust trench depths to accommodate bedding where required. The padding and bedding materials shall be sieved to a maximum allowable of 4mm size, approved by the Engineer. Large objects shall not be dumped into the trench. Removal of rubble shall be the responsibility of the Contractor.

All ducts and pipes shall be well sealed at entry/ exit points of manholes/handholes. General Backfill shall consist of the material excavated from the trench, provided that:

- a) The material is easily workable and compactable;
- b) The material is free from organic material (roots, grass etc.) rubbish, clay lumps and aggregates stuck on the 4mm sieve shall be disposed of; and
- c) The material has suitable moisture content and is not too dry.

If the site materials cannot meet these requirements, then suitable material shall be imported. Compaction of suitable bedding material of thickness 100 mm shall be achieved by passes over the whole trench bed, preferably using a Power Vibrating Rammer or a 5 kg hand rammer as an

alternative. The cable/duct/sleeve shall then be laid on the prepared bed. For any variations to this procedure, approval shall firstly be required from the Engineer.

An appropriate amount of slack shall be looped and retained where splices are to be made (at all designated sites). Self-expanding polystyrene type foam shall be injected into the communication tube openings after the cable has been pulled in to seal the ends of the tubes and to stop the ingress of sand, rodents, etc. at these manholes.

All trenches shall be backfilled with suitable material that is easily workable and compactable. The backfill material shall be free from grass and roots. If the backfill material is too dry, it shall be moistened prior to placing and compacting.

Each layer of 150 mm thick compacted backfill shall be tested to the following requirements using the standard 5 kg DCP test method or an appropriately SABS recognised Density Test Method:

Road Trenches: Minimum of 5 blows per 100 mm penetration

Sidewalk, driveways and median trenches: minimum of 3 blows per 100 mm penetration

Verge trenches: minimum of 2 blows per 100 mm penetration

Trenches in the verge (unhardened areas) may be backfilled and compacted in 300 mm loose layers. All test results shall be recorded and handed to the Engineer. The Engineer reserves the right to carry out their own DCP testing and should minimum requirements not be achieved on completed work, the Contractor shall be required to remove and redo the operation to ensure compliance.

The procedure to deal with existing services shall be as follows:

- a) Where required trenches have been identified in areas by the Contractor, and where infrastructure are/may be prevalent, pilot holes shall be dug at intervals along that run.
- b) These pilot holes shall be dug either as per one or a combination of the following:
 - ≤ 20 m for trenches less than equal to 200m
 - ≤ 25 m for trenches greater than 200m
 - Or as per the site requirements and/or site instruction.
- c) Pilot holes shall be dug at points where the new trench crosses known existing services, according to way leave plans and/or other drawings and including verbal communication from the client's site personnel.
- d) The pilot holes shall be at least 150 mm deeper and wider than the proposed excavation so as to reveal the presence of any services belonging to other administrations.
- e) These Pilot holes shall be dug by hand, and with the utmost of care.
- f) All excavation work shall be performed under the supervision of a responsible and competent person who shall be competent to exercise such supervision.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- g) Failure to abide by any of the above instructions, may/can lead to damages to existing services. The contractor shall be liable for all damages to existing services, and the subsequent repairs shall be carried out by the contractor without any delay.

The trench shall be laid out in such a position that the cables/ducts/sleeves shall be laid at least 300 mm from power cables. Where this is not possible with services that are in the way of the cable/duct/sleeve and if there is insufficient space for the 300 mm separation, then the cable/duct/sleeve shall be tunnelled 300 mm underneath the other services. Storm-water gutters and drains shall not be obstructed.

Where it is not possible to get the minimum required depth, the cables/ducts/sleeves must be boxed in concrete to a required thickness of 50 mm and strength of 20 MPa. Trenching for cables shall be excavated in straight lines in accordance with the servitude/way leave plan, except where obstruction or other conditions occur. These areas shall be pointed out to the Engineer for his approval on any route diversions.

Before commencing with cable/duct/sleeve-laying operations in an excavated trench the Contractor shall suitably prepare the trench floor to provide firm support for the cable/duct/sleeve over their full length. To this end he must ensure that the trench floor is free from all loose and or unsuitable material, including soil saturated with water, evenly levelled and at the proper depth required for the cable/duct/sleeve.

The Contractor shall exercise due care in trimming and/or undercutting trench floors to ensure that only the necessary amount of ground is removed. Should the Contractor remove, either by neglect or bad workmanship more ground than is necessary, he shall at his own cost fill such excess excavation with compacted bedding material.

The Contractor shall pay particular attention to the proper compaction of bedding, padding and backfilling material. The approved type of marker tape, orange in colour and a minimum width of 150mm (warning tape with inscription: "**Warning - Fibre Optic Cable Below**" for Fibre and **Electric Cable Below**) shall be laid 300 mm above the cable/duct/sleeve over the entire length of the cable/duct/sleeve run. A high standard of compaction effort shall be incited upon in all cases where fine materials are approved as bedding and padding.

The Contractor shall supply tamping tools for the manual compaction of padding material immediately adjacent to and between the cable/duct/sleeve. A suitable tamping tool shall be provided similar to the following:

- a) A tamping foot made up of a 37 mm diameter steel rod 300 mm long securely attached to a vertical handle made up of 20 mm steel rod 1.35 meters long.

During the compaction of padding and backfill material the Contractor must exercise due care to ensure that cable/ducts/sleeves are not disturbed or damaged in any way. The use of non-cohesive, single size, graded sand or crusher sand for bedding, surround blankets and backfilling of trenches shall not be permitted.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

NOTE: Tenderers shall acquaint themselves fully with the nature and formation of the ground in which the cables are to be laid, before submitting a Tender. No subsequent claim for extras due to lack of knowledge in this respect will be entertained by the Employer.

Cable trenches for low Voltage power and lighting cables shall be deep enough to facilitate the laying of these cables at a depth of minimum of **750mm** below final ground level.

Trenches for Medium Voltage power cables shall be deep enough to facilitate the laying of these cables at a depth of **1000mm** below ground level. The floors of all cable trenches shall be smooth and free from boulders and sharp rock projections.

Each cable shall be laid in a bedding of river sand or sifted soil [4mm sieve – the soil shall first be approved by the Engineer] 75 mm over and 75 mm below the cable. Clayey soil will not be accepted as bedding.

o cable trench shall be back-filled before the cable(s) in the trench has been inspected and approved by the Engineer.

EMCA 8.3 Under Ground Cable Pipes

Cable pipes will be supplied and installed by others unless indicated otherwise on the drawings.

Each cable pipe shall be sealed by the Contractor under this Contract at both ends by means of bitumen impregnated jute bags or similar material, after the cable has been installed.

EMCA 8.4 Cable Slabs

Where electrical cables cross above other services such as water pipes, sewerage pipes, other electrical cables, pilot cables and telephone cables or where danger exists that cables may be damaged due to excavations by others cables shall be protected by means of reinforced concrete slabs. The concrete slabs shall protect the cable for at least 0,5 m in both directions of the crossing.

Where electrical cables cross underneath other services such as water pipes, sewerage pipes, post office cables etc. a concrete slab shall be placed above and axial with the other service and should the free space between the two services be less than 300 mm an additional slab shall be placed axial with the electrical cable between the two services.

Where cables are laid down a grading and a possibility exist that the cables might be washed open due to rain, then cable slabs shall be placed on top of the cables for the entire length of the grading.

The concrete slabs shall be supplied and installed under this Contract.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

EMCA 8.5 Cable Crossing With Other Services

EMCA 8.5.1 General

Where a cable is laid above another service it shall not be less than 750 mm below ground level, and if this is not possible, the cable shall be laid underneath the other service and shall be protected by means of concrete slabs in the manner prescribed. The deeper or shallower positions of the cable shall only apply for a distance of 1 m on both directions of the crossing.

If not possible to cross underneath the other service the matter shall be referred to the Engineer for a decision.

EMCA 8.5.2 Clearances

The following minimum clearances shall be maintained between electrical cables and other services:

DESCRIPTION	VERTICAL	HORIZONTAL
Telkom cables	0,3m	0,3m
Other water pipes	0,3m	0,3m
Sewerage pipes	0,3m	0,8m
Storm water pipes	0,3m	0,6m
Other Electrical cables	150mm	150mm

EMCA 8.6 Cables must be Laid without Delay

The cables shall be laid with the minimum of delay in order to backfill the trenches as soon as possible.

The Contractor shall, however not backfill the trench until each length of cable has been tested, inspected and approved by the Engineer.

Only one cable shall be laid at a time and the Contractor shall ensure that cables already laid are not damaged.

EMCA 8.7 Method

All cables shall be handled with the utmost care and shall be laid in accordance with the best methods observed in good modern practice. All cables shall be run out on rollers in order to prevent abrasion and no cable shall be dragged along the ground. No cable shall be bent to a radius of less than 12 times its overall diameter.

a) In Concrete Ducts

Cables shall be laid neat parallel with each other on the floor of the duct with the maximum spacing. Any other cables shall be installed on cable ladders secured to the vertical sections of the cable ducts.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

b) On cable ladders

Cable shall be installed neat and parallel with each other with the maximum spacing. On Horizontal sections the cables shall be secured to the cable ladders with intervals of not more than 2m. On vertical sections or where the cable ladders are installed at an angle the cables shall be secured to the cable ladders with intervals of not less than 500mm with suitable strapping material approved by the Engineer.

Either stainless steel or hot dipped galvanized steel cable strapping material shall be used on outdoor cable installations depending on the cable rack or ladder material.

Sections of the cable ladders shall be electrically connected and provision shall be made for crimping and expansion of the racks.

c) In Trenches

Two or more L.T. cables in the same trench shall be laid in a straight line and in parallel and not less than 75mm apart between cable route turning points, except where otherwise approved. Cable routes shall always follow routes parallel to permanent structures to facilitate as built information.

H.T. cables in the same trench shall be laid parallel and not less than 150mm apart, except where otherwise approved.

All L.T. power cables shall be laid 750mm below final ground level and H.T. power cables shall be laid 1 m below final ground level.

The contractor shall provide 3m slack at each end in each run of power cable and its associated earth wire and bury the same in the ground as near to the relevant end as possible. Where the cables and earth wires are to be installed in open ducts outside buildings, the slack shall be coiled in the ducts.

The separation between any signal cable and the nearest parallel power cable shall not be less than 150mm.

d) Against Walls

Cables and earth wires to be installed on walls, where approved by the Engineer, shall be neatly installed on heavy-duty hot dipped galvanised steel cable racks. Cables and earth wires on outside walls shall be installed in a similar manner or in suitably sized hot dipped galvanised conduit from 300 mm below up to 2,4 m above final ground level or as required. These conduits shall be secured to the walls by means of hot dipped galvanised steel bat holders at intervals not exceeding 600 mm. (Hospital Saddles).

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Saddles shall only be secured by means of round-headed hot dipped galvanized screws and plugs of an approved type. (Wood will not be accepted as plugging material.) Plugs will not be allowed in joints between bricks.

e) On Poles

Cables and earth wires to be installed on poles shall be secured to the poles at intervals not exceeding 600 mm by means of 25 mm x 1,5 mm adjustable Grade 304 Stainless Steel straps. Each cable together with its associated earth wire shall be installed in a suitably sized stainless steel pipe or channel from 300 mm below up to 2,4 m above ground level. This pipe or channel shall be secured to the pole by means of 25 mm x 1,5 mm adjustable stainless steel straps at intervals not exceeding 600 mm. To avoid metallic action between different materials Neoprene rubber strip shall be installed between the pole and the strap.

f) Cable Channels on Structures and in Buildings

Where cable channels have been provided on structures and in buildings these must be backfilled with river sand by the contractor.

g) Cables connected to motors and other equipment

Cables and earth wires connected to motors and other equipment shall be secured between the cable channels, cable rack or cable tray to the point of termination by means of a heavy-duty hot dipped galvanised type of cable support. The cable shall be secured to the cable support by means of steel straps or other acceptable strapping material.

EMCA 8.8 Inspection of Cables and Cable Trenches

After the cables have been installed and spaced on top of the 75mm thick layer of sand in the trenches, the installation shall first be inspected and approved by the Engineer before the trenches may be refilled. Should the Contractor not meet with the requirement, or if he fails to give the Engineer sufficient notice of an inspection, portions of the trenches or the complete trench shall have to be re-excavated by the Contractor at his own expense for inspection by the Engineer.

A logbook with three copies per page shall be kept by the Contractor on the site, in which each part of the installation that has been inspected can be recorded after inspection and approval.

EMCA 8.9 Backfilling of Trenches

Once the cable has been laid, straightened, inspected, approved and covered with the top layer of bedding soil, the trenches shall be backfilled with soil which does not contain more than 40 % rock or shale and will pass through a sieve with 100 mm diameter holes that has been approved by the Engineer.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Back filling of cable trenches shall be done in layers of 150 mm and shall be compacted and consolidated to 95% modified AASHTO. Test shall be carried out to ensure the required compaction at the cost of Contractor.

The Contractor shall maintain the closed up sections of the cable trenches in a proper, safe condition for the duration of the contract. Where the soil in the trenches subsides it shall be refilled and compacted to the satisfaction of the Engineer.

Bedding: This shall refer to the material constituting the even floor of an excavated trench onto which a duct or a bank of ducts is laid (+/-100mm).

Padding: This shall refer to the material installed around and/or between ducts up to a level of at least 150 mm above the duct or bank of ducts.

Backfilling: This shall refer to the material installed above the padding material layer to complete the refilling of an excavated trench.

The 3 layers of material in the backfilled trench shall be classified as bedding, padding, and main backfill. The bedding and padding material shall not be too fine, and shall be free of large stones (it shall be evenly graded between 0,6 mm and 19 mm). Clay type material shall not be acceptable (the PI shall not exceed 12 and the compaction factor shall not exceed 0.4).

EMCA 9 INSTALLATION OF CABLE TRAYS AND CABLE LADDERS

The cable ladders shall be secured on suitable lengths which shall be suspended from the roof slab by means of suitable lengths 8 mm dia threaded hot dipped galvanized steel rods or secured to the walls with suitable sized hot dipped galvanized steel Rawl type bolts and shall be secured to the channel sections by means of two hot dipped galvanized nuts and washers.

The different parts of the trays and ladders must be thoroughly bonded electrically and mechanically to each other.

The cable trays and ladders shall be installed neatly, level and square/parallel to walls.

Cable straps suitable for the specific cable shall be employed to secure the cable onto the tray. Outdoor cable straps shall be stainless steel and cables shall be secured on intervals not exceeding 600mm. Cables on cable trays or ladders in outdoor environments shall be covered with removable cable tray or ladder covers of similar material.

EMCA 10 CABLE SUPPORTS TO MOTORS AND OTHER EQUIPMENT

Cables to motors and other electrical equipment shall be supported by means of hot dipped galvanized cantilever brackets and cable supports. Cables shall be strapped to these supports by means of acceptable strapping material.

EMCA 11 WIRE TRUNKING

Heavy duty hot dipped galvanised wire trunking of sufficient dimensions shall be installed against all large capacity pump set concrete plinths for installation of pump set protection sensor monitoring cables. The monitoring cables shall be installed in hot dipped galvanised conduit from the trunking to the sensor position.

EMCA 12 SENSOR TERMINATION CUBICLE

All large capacity pump set sensor cables shall be terminated in a powder coated mild steel frame mounted termination cubicle with lockable front door secured against the pump set plinth. DIN rail mounted cable conductor termination blocks shall be installed inside the termination cubicle for cable conductor termination.

EMCA 13 CABLE MARKERS

Cable ends shall be properly labelled with reference to equipment, section of plant and other requirements specified by the client at both cable ends.

Cable markers with lead labels cast into the top of the cable markers shall be supplied and installed along the cable routes under this Contract as follows:

Along straight runs of the route, not further than 25 m apart;

At turns - one on each side of the turning point, 900 mm from such turning points;

At each branch, 3 markers - i.e. one on each side of the branch, 900 mm from the branch.

The cable markers shall be installed deep enough to ensure that the top of the marker will protrude 50 mm above final ground level.

EMCA 13.1 Name Tags

Identification tags shall be attached to all cable ends. The tags shall be secured to cables by means of cable ties to the approval to the Engineer.

Cables shall be tagged at either end, whether the end terminates in a distribution board or an end box.

All cable cores and internal panel wiring shall be identified at both ends by means of durable colour coded wire marking ferrules in accordance with numbering systems in cable and wiring diagrams. Only closed ring interlocking type identification ferrules shall be used.

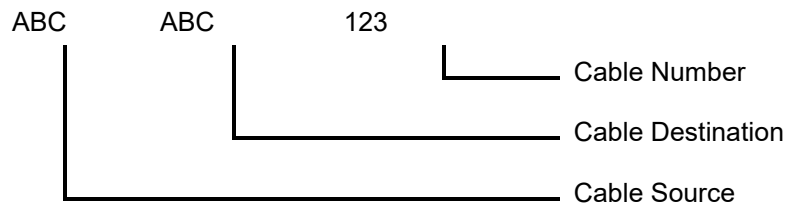
Outdoor tags shall be of stainless steel or brass type and shall be secured by means of similar strapping material.

Tags mounted indoors or protected by an enclosure shall be made of Ivorene or similar sandwich material with black letters on a white background.

All lettering and text shall be approved by the Engineer.

Letter sizes must be compatible with the application and shall not be smaller than 8mm.

a) Cable Naming Convention



b) Table of Areas

Example of area abbreviations:

ILW	-	Inlet works
IMC	-	Inlet motor control centre

c) Example of cable schedule;

Cable Number	From	To	Grade (V)	Size mm ²	No. of cores	Length (m)
ILW-IMC-001	Inlet works	Inlet motor control centre	400	185	4	55
IMC-SCR-001	Inlet works MCC	Screen 01	400	10	4	25

EMCA 14 WARNING TAPES

Warning tape shall be installed along all trench excavated cable routes 300mm above the cables.

Warning tape shall have a minimum width of 300mm and have a bright orange colour with the wording "Danger". The minimum thickness shall be 800 gauge.

EMCA 15 EARTH WIRES

Earth wires shall be installed with L.T. cables as and where indicated on the drawings or specified herein and shall consist of bare hard-drawn copper wire.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

These earth wires shall be installed at the same depth as the relevant cables, with at least 75 mm clearance between any earth wire and the nearest cable, unless specifically approved otherwise.

No joint will be allowed in any run of earth wire.
Each earth wire shall be terminated at each end by means of a suitably sized bolted lug either sweated or crimped onto the wire. The lugs shall be bolted onto the relevant earth bars or earthing terminals.

EMCA 16 TESTING OF CABLES

EMCA 16.1 Low Voltage Cables

On each completed section of laid and jointed cable, the insulation shall be tested to approval with an approved "Megger"-type instrument of not less than 500 V.

EMCA 16.2 Medium Voltage Cables

On each completed section of laid and jointed high tension cable a high voltage test shall be carried out. The test shall be performed according to SABS 97 of 1991. Alternating or direct current may be used.
A certificate shall be submitted confirming the successful testing of the relevant cable.

EMCA 17 ROUTE PLANS TO BE SUBMITTED BY THE CONTRACTOR

On completion of the works, but before the certificate of completion will be issued, the contractor shall submit to the Engineer, route plans in electronic format indicating in a satisfactory manner:

- (a) The exact cable routes with reference to fixed points (e.g. buildings);
- (b) The exact lengths of cable (HT and LT) installed between terminating points and between joints where relevant; and
- (c) With reference to fixed points the exact positions of cable joints (e.g. buildings).

Electronic copies of the various plans for the marking up of the information required will be supplied to the contractor on request.

EMCA 18 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EMCA 18.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For multicore cables and earthwires, design information shall include, but limited to as listed in this Particular Specifications.

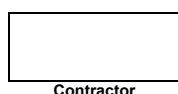
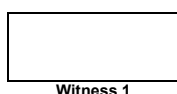
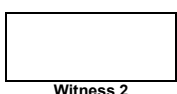
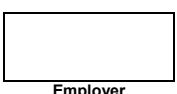
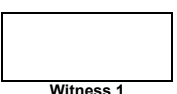
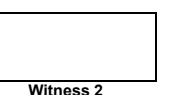
The Contractor shall be required to complete this design and engineering tasks and the contractor shall allow adequate time for the complete design and engineering of the multicore cables and earthwires.

<u>Pay Item</u>	<u>Unit</u>
(a) The Contractor will provide the following design calculations, drawings, method statements, cable routes, cable schedules in excel format which will include but limited to From, To, Distance and Tag numbers all to the approval of the Engineer [Refer to particular specification EMCA 3.3.2, 8.7 & 17]	Sum
(b) Provide operating and maintenance manuals, all data sheets [a) cables, b) joint kits, c) ladders, d) glands, conduit, fasteners and all that are used and etc] and furthermore the Contractor to supply as built" drawings	Sum

EMCA 18.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For multicore cables and earthwires, the rate tendered shall be for the multicore cables and earthwires and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications and schedule of quantities.

<u>Pay Item</u>	<u>Unit</u>
(a) Supply and delivery to site of multicore cables and earthwires and cable name tags for the following cables as per the particular specification	Meter (m)
(b) Supply and delivery to site of all multicore cables and earthwires termination materials [equal or similar to Enviro Glands, neoprene shrouds, lugs, insulating, materials, cable ties and corrosion proof bolts, washers, spring washers, nuts, etc] to terminate the following cables as per the particular specification	Each
(c) Supply and delivery to site of cable route markers	Each
(d) Supply and delivery to site of concrete cable slabs	Each
(e) Supply and delivery to site of [Type] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Meter (m)
(f) Supply and delivery to site of [Type] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular	Each

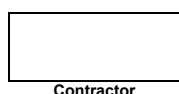
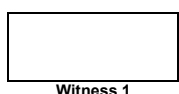
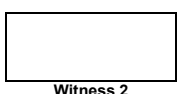
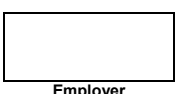
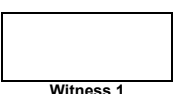
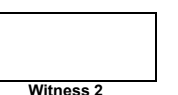
					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

	specification	
(g)	Supply and delivery to site of all [Type] heavy-duty cable ladder supports, bolts, holders and etc that is required as per the particular specification	Sum
(h)	Supply and delivery to site of pump set sensor termination cubicles	Each
(i)	Supply and delivery to site of HPDE heavy-duty cable sleeves, joints, sealing rings, couplings, end plugs, spacer modules, bell mounth, manderel, duct brush flexibend, stainless steel draw wire long bend as per the particular specification	Meter (m)
(j)	Supply and delivery to site of all Equal or similar Pratley EZEE-Fit with solid cover IP68 including non sparking connectors, insulating sleeves, identification tag, mounting screws, locknuts , lockout device with lock, lid securing chain and all accessories	Each
(k)	Supply and delivery to site of all 316 Stainless Steel Conduit with saddles, fasteners, surface mounted against brick or concrete every 500mm and all accessories	Meter (m)
(l)	Supply and delivery to site of all soil for the bedding of cables during excavations including cleaning of cable routes complete as per particular specification.	m ³

EMCA 18.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of multicore cables and earthwires shall be accordance with the manufacturer's written instructions and recognized industry practices, the above particular specification, to ensure that the multicore cables and earthwires complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation" and particular specification, for installation of multicore cables and earthwires but not limited to.

<u>Pay Item</u>	<u>Unit</u>
(c) Installation of all multicore cables and earthwires and cable name tags for the following cables as per the particular specification	Meter (m)
(m) Installation of all multicore cables and earthwires termination materials [equal or similar to Enviro Glands, neoprene shrouds, lugs, insulating, materials, cable ties and corrosion proof bolts, washers, spring washers, nuts, etc] to terminate the following cables as per the particular specification	Each
(n) Installation of cable route markers	Each
(o) Installation of concrete cable slabs	Each
(p) Installation of [Type] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking,	Meter (m)

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

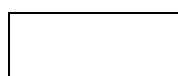
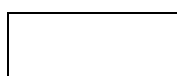
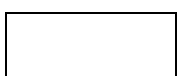
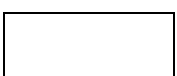
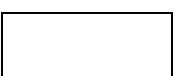
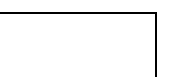
	bolts, nuts and anchor bolts etc as per the particular specification	
(q)	Installation of [Type] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Each
(r)	Installation of all [Type] heavy-duty cable ladder supports, bolts, holders and etc that is required as per the particular specification	Sum
(s)	Installation of pump set sensor termination cubicles	Each
(t)	Installation of HPDE heavy-duty cable sleeves, joints, sealing rings, couplings, end plugs, spacer modules, bell mounth, manderel, duct brush flexibend, stainless steel draw wire long bend as per the particular specification	Meter (m)
(u)	Installation of Equal or similar Pratley EZEE-Fit with solid cover IP68 including non sparking connectors, insulating sleeves, identification tag, mounting screws, locknuts , lockout device with lock, lid securing chain and all accessories	Each
(v)	Installation of 316 Stainless Steel Conduit with saddles, fasteners, surface mounted against brick or concrete every 500mm and all accessories	Meter (m)
(w)	Installation of all soil for the bedding of cables during excavations including cleaning of cable routes complete as per particular specification.	m ³
(x)	Excavating, back filling, consolidation, importation of soil and dumping of all rock and stone removed during excavations including cleaning of cable routes all according to particular specification (including hand excavations where necessary along existing cable routes.	Sum

EMCA 18.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

<u>Pay Item</u>	<u>Unit</u>
(a) Testing and commissioning of all cables	Sum
(b) Updating, verifying and submission of Electronic Cable schedules with Tag numbers and final agreed lengths	Sum
(c) Surveyor to mark-up as-built cable route plans and all mark-up must be on made on the AutoCAD format	Sum

END OF SECTION

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2



RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

ESLS SITE LIGHTING SYSTEM

INDEX

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ESLS 4	STREET TYPE SITE LIGHTING SYSTEM	230
ESLS 5	MEASUREMENT AND PAYMENT	231

ESLS SITE LIGHTING SYSTEM

ESLS 1 SCOPE

As specified in the Project Specifications.

ESLS 2 STANDARDS AND TESTS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Standard No.	Description
SANS 156	Moulded case circuit breakers
SANS 1777	Photoelectric control units for lighting
SANS 10142	Code of Practice for the wiring of Premises
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1063	Earth rods and couplers
SANS 1213	Mechanical cable glands
SANS 1433-1	Terminal blocks having screw and screwless terminals
SANS 10199	The design and installation of an earth electrode
SANS 10292	Earthing of low-voltage distribution systems
SANS 10313	The protection of structures against lightning

ESLS 3 15M MAST SITE LIGHTING SYSTEM

The site lighting system will consist of a 15m mast, fitted with 160 W LED flood lights complete with control gear as specified in the project specifications.

Each scissor mast shall be equipped with three (3) floodlights and shall be balanced for easy and safe lowering of mast.

ESLS 3.1 Adjusting Of Luminaires

The Tenderer must allow in his Tender for at least one visit to site after dark for adjusting of the luminaires in the presence of the Engineer.

ESLS 3.2 15m Scissor Type Masts

The hinged masts complete with the foundation, prescribed luminaires, circuit breakers inside the mast must be supplied and installed under this contract.

ESLS 3.3 Lighting Columns

The columns offered shall have an overall floodlight mounting height of 15 meters. The cross section and wall thickness of the columns offered shall be determined by the Tenderers on the basis of working loads. However, the manufacturer shall reinforce the column in those sections

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

which are stressed by the frame during raising and lowering to ensure that the metal in these sections shall not crack, tear, stretch or be damaged in any way. The top of the columns shall have suitable mounting brackets to suit the floodlights offered.

ESLS 3.4 Construction

The column shall be continuously tapered and shall be equipped with tamper-proof locking device for the raising and lowering action of the column.

ESLS 3.5 Protection and painting

All steel parts of the mast and head frame shall be heavy duty hot-dip galvanised.

ESLS 3.6 Electrical equipment and mounting plate

Each flexible multi core cable shall be 600/1000V rated, with a minimum 4 mm² diameter PVC/SWA/PVC copper cable with suitable number of cores. Each core shall be rubber insulated and the multi core cables shall be overall sheathed to give a circular form. The final sheath shall be of chloroprene.

The cable shall have numbered cores with one green/yellow earth core.

The cable shall be provided with an approved tension sock at the point of suspension.

In the event of the luminaire control gear being situated at the bottom of the mast, special cables shall have to be used to allow for the higher voltage, as required. Details of these cables have to be submitted to the Engineer for approval.

ESLS 3.7 Access door to electrical equipment

The access door shall be close fitting, vandal resistant and weatherproof.

ESLS 3.8 Transport

Special care must be taken in the handling of the galvanised mast during loading and off-loading to avoid any damage to galvanised surfaces. During transit, the mast must be supported on wooden blocks and secured in position to avoid surface damage.

ESLS 3.9 Guarantee

The manufacturer shall guarantee the column against faulty workmanship, incorrect design and material specification. Should the column be damaged due to any of the above, the manufacturer shall replace the damaged mast and fittings at own expense. All electrical equipment shall be guaranteed against faulty workmanship for a period of one year as described in the Conditions of Contract.

ESLS 3.10 Installation of masts

The masts shall be installed in accordance with the manufacturer’s Specification.

ESLS 3.11 Earthing

Each mast shall be earthed by means of at least 4 x 1,2m earth spikes to allow an earth resistance of 1 ohm or less. Each spike shall be connected with a 70mm² bare copper conductor to the bolting-down assembly inside the concrete foundation. Approved clamps shall be used to ensure positive contact at the connection point between the copper and steel.

The earthing of the electrical installation of the mast is by means of the earthing supplied with the feeder cable. The earth bar in the distribution board shall be connected to the earth stud in the mast.

ESLS 3.12 Pole Lightning arrestor

The contractor shall install a pole lightning arrestor on the top of the high mast to protect the luminaires from direct lightning strikes.

A "Copper weld" copper steel bi-metallic rod with a spindle on top shall be used for the pole arrestor. The minimum length of the pole arrestor shall be equal to the radius of the luminaire cluster with the luminaires installed. The diameter of the "Copper weld" rod shall be submitted to the Engineer for his approval.

The pole arrestor shall be attached to the top column of the mast by means of two non-ferrous mechanical clamps and bolts. A 70mm² single core copper earth conductor shall be installed inside the mast. A cable lug shall be crimped on the two ends of the earth conductor for bolting to the earth bar and pole arrestor as appropriate. Any type of brazing will not be permitted.

ESLS 3.13 Delivery

Prices quoted shall make provision for supply, delivery and installation of material on site.

ESLS 4 STREET TYPE SITE LIGHTING SYSTEM

ESLS 4.1 Street Lighting System

A standard type streetlight mast for suburban routes with total length of 8,5m and single outreach arm of 0,5m complete with 36W LED light fitting and 36W LED lamp shall be supplied and installed as specified and indicated on drawings.

The mast shall be complete with base plate, bottom cable entry, switchgear compartment with removable cover, cable gland plate, 5A circuit breaker and mounting strip for clip on terminal blocks.

ESLS 4.2 Protection and Painting

All steel parts of the mast and head frame shall be heavy duty hot-dip galvanized.

ESLS 4.3 Electrical Equipment and Mounting Plate

Each mast shall be equipped with a hot dipped galvanized gland plate with provision for two number 2 PVC SWA PVC cable glands as well as Din rail mounted type connector blocks for conductor connection and 5 Amp circuit breaker.

ESLS 4.4 Flexible Multi Core Mast Cables

Each flexible multi core cable shall be 600/1000V rated, with a minimum 4 mm² diameter PVC/SWA/PVC copper cable with suitable number of cores. Each core shall be rubber insulated and the multi core cables shall be overall sheathed to give a circular form. The final sheath shall be of chloroprene.

The cable shall have numbered cores with one green/yellow earth core.

The cable shall be provided with an approved tension sock at the point of suspension.

ESLS 4.5 Access Door to Electrical Equipment

The access door shall be close fitting, vandal resistant and weatherproof.

ESLS 4.6 Transport

Special care must be taken in the handling of the galvanised mast during loading and off-loading to avoid any damage to galvanised surfaces. During transit, the mast must be supported on wooden blocks and secured in position to avoid surface damage.

ESLS 4.7 Installation Of Masts

The masts shall be installed in accordance with the manufacturer's Specification.

ESLS 4.8 Earthing

The earthing of the electrical installation of the mast is by means of the earthing supplied with the feeder cable. The earth bar in the distribution board shall be connected to the earth stud in the mast.

ESLS 5 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Vol3_C3.4.3.2_June25_Standard_and_Particular_Specs_Electrical

ESLS 5.1 Supply and Delivery to Site

<u>Pay Item</u>	<u>Unit</u>
Supply and delivery to site of complete mast as specified	Sum
Supply and delivery to site of complete streetlight pole as specified	Sum

ESLS 5.2 Installation

<u>Pay Item</u>	<u>Unit</u>
(d) Installation of complete mast as specified	Sum
Installation of complete streetlight pole as specified	Sum

ESLS 5.3 Commissioning

<u>Pay Item</u>	<u>Unit</u>
(a) Commissioning of complete mast as specified	Sum
Commissioning of complete streetlight pole as specified	Sum

END OF SECTION

RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER TREATMENT
WORKS – MECHANICAL AND ELECTRICAL WORKS**

ESGS: STANDBY GENERATOR SYSTEM

INDEX

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ESGS STANDBY GENERATORS

ESGS1 SCOPE

As specified in the Project Specifications

ESGS2 STANDARDS

Cables shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and International Standards:

The following Standard Specifications and drawings shall apply:

Standard No.	Description
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 10142	Code of Practice for the wiring of Premises
NRS 016	Code of practice for earthing of low voltage distribution systems
NRS 053	Medium voltage cable joints and termination kits
BS 5000-3:2006	Rotating electrical machines of particular types or for particular applications. Generators to be driven by reciprocating internal combustion engines. Requirements for resistance to vibration
BS ISO 3046-1:2002	Reciprocating internal combustion engines. Performance. Declarations of power, fuel and lubricating oil consumptions, and test methods. Additional requirements for engines for general use
BS ISO 3046-3:2006	Reciprocating internal combustion engines. Performance. Test measurements
BS ISO 3046-4:2009	Reciprocating internal combustion engines. Performance. Speed governing.

ESGS3 GENERATOR DETAILS

This item shall comprise the supply and installation of a suitably rated fully automatic standby diesel-alternator set(s) in order to meet at least 120 % of the required maximum demand.

The set shall be operated as an automatic mains failure set with an automatic switch back to main supply system.

The supply and installation of fuel pipes, lubrication oil make-up tanks, oil pipes, starting batteries, inlet air louvers and screen, exhaust silencers and piping, engine protection panels, electrical protection, control panels, attenuation canopy and all the electrical cabling and connections necessary for the complete installation shall be included under this Contract. The set shall be installed on a suitable concrete plinth, provided by others, complete with cable entries.

ESGS4 COMPOSITION OF STANDBY GENERATOR SYSTEM

The installation shall comprise of the following items;

- Fuel piping,
- One or more engine-alternator unit/s
- Engine control/protection, automatic voltage regulator excitation panel,

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- One set of engine starting batteries, and charging alternator on the engine/s,
- One set of engine exhaust piping and silencer per engine,
- All the interconnecting cables as well as all the cables to link up with the electricity distribution system on the electrical motor control centre in a separate control room.
- Day tank for the generator set/s,
- The generating set shall be a self-contained unit, installed in a suitable 3-CR-12 powder coated steel container with tamper free door lock mechanisms complete with attenuating louvers.
- All the necessary synchronizing, and load sharing equipment as well as the protection in this respect must be supplied and installed under this Contract. The equipment shall be of well-known and widely maintenance supported manufacture.
- Any other items and auxiliaries to complete the entire installation.

ESGS5 ENGINE ALTERNATOR SET MOUNTING AND COUPLING

The engine, cooling water radiator and generator shall be moulded on a common rigid sub-frame fabricated from rolled steel sections. The sub-frame shall be secured by means of anti-vibration mountings to another fabricated, skid-type steel base frame, suitable for rigid bolting to the foundation. The outer frame shall be equipped with lifting bars suitable for attaching slings to facilitate handling.

The alternator shall be flange-moulded to the engine and the drive to the generator shall be by means of a suitable flexible coupling.

An oil tray shall be provided over the full length of the engine. The sump drain shall extend to outside the base frame.

ESGS6 ENGINE

The engine shall be multi-cylinder, four stroke direct injection, compression ignition type in compliance with BS ISO 3046. The engine shall be de-rated for site conditions in accordance with BS ISO 3046. The engine shall be capable of delivering the output continuously with a 10% overload capacity for any 1-hour in any 12-hours continuous running. The engine must be suitably rated to take full load in one single step.

The engine shall have the following features or auxiliaries:

- Speed 1500 rpm maximum
- Turbo charging and after cooling affect not exceeding 20 % of the prime power output.
- Thermostatically controlled 220V jacket water heater to ensure positive starting at minimum ambient air temperature.
- Electric starter and manual starting buttons.
- Cyclonic type two stage air filters.
- Pressure lubrication.
- Full flow lubricating oil filters.
- Fail safe fuel cut-off solenoid.

- Lubricating oil pressure gauge.
- Cooling water temperature gauge.

ESGS6.1 Starting and Stopping

The starting period for either manual or automatic switching on until the taking over by the generating set, in one step of a load equal to the specified site electrical output, shall not exceed 15 seconds.

The engine shall be fitted with an electric starter motor and be easily started from cold, without the use of any special ignition devices under summer as well as winter conditions.

Tenderers must state what arrangements are provided to ensure easy starting in cold weather. Full details of this equipment must be submitted. In the case of water-cooled engines, any electrical heaters shall be thermostatically controlled. The electrical circuit for such heaters shall be taken from the control panel and must be protected by a suitable circuit breaker.

ESGS6.2 Starter Battery

The genset to be supplied with a fully charged lead acid type battery, complete with necessary electrolyte with capacity as specified below;

- Sufficient starting ampere in order to provide the starting torque stipulated by the engine makers.
- Capacity not less than 120 Ah
- Capable of providing six starts in quick succession. The last three attempts being manual and of 5 second duration.

The battery must be of the heavy duty "low maintenance" type, house in a suitable battery box.

ESGS6.2.1 Battery Charging

A trickle charger shall be incorporated to keep the starting battery in a fully charged state from the mains supply when the set is operated as a standby set. The charger shall be of the constant voltage type with current limiting. A voltage trimming adjustment shall be provided which is accessible by screwdriver from the inside only. The input to the charger shall be fuse protected.

The starting batteries shall be mounted on a stand and thereby kept off the floor.

ESGS6.3 Cooling

The engine may be either of the air or water cooled type.

In the case of water-cooling, a built-on heavy duty, tropical type pressurised radiator on engine alternator set base and engine driven fan and cooling water pump must be fitted. Only stand-by sets that are water cooled shall have electric heaters.

For either method of cooling, protection must be provided against running at excessive temperatures. The operation of this protective device must give a visual and audible indication on the switchboard. Water-cooled engines shall in addition be fitted with a low water cut-out switch, installed in the radiator, to switch the set off in the event of a loss of coolant. The protection shall operate in the same way as the other cut-outs (e.g. low oil pressure). All air ducts for the

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cooling of the engine are to be allowed for. The air shall be supplied from the cooling fan cowl/radiator face to air outlet louvers in the plant room wall.

ESGS6.3.1 Inlet And Outlet Air Openings And Ducting

The sizes of the building openings shall be designed by the contractor to ensure that inlet and outlet openings shall be sufficient to prevent overheating of the set/s.

The openings shall be flanged and framed by means of 6mm flat steel onto which the Contractor shall supply and mount by means of drilling and tapping screens and louvers to suit his plant.

Hot air ducting of galvanised sheet, with a flexible section shall also be supplied and installed between the engine cooling water radiator and the outlet opening.

ESGS6.4 LUBRICATION

Lubrication of the main bearings and other important moving parts shall be by forced feed system. An automatic low oil pressure cut-out must be fitted, operating the stop solenoid on the engine and giving a visible and audible indication on the switchboard.

ESGS6.5 FUEL SYSTEM

ESGS6.5.1 Fuel Pump

The fuel injection equipment is suitable for operation with the commercial brands of diesel fuel normally available in South Africa.

ESGS6.5.2 Fuel Tanks

A hot dipped galvanised frame mounted bulk fuel tank shall be supplied and installed. The capacity shall be enough to supply full load for at least 24 hours. The fuel tank should be installed on a concrete plinth with bunted walls as provided by the civil contractor. The exact location of the bulk diesel storage will be as indicated on the drawings.

A level control unit shall be installed in the day tank to activate a relay in the generator control panel.

The relay shall be supplied with an auxiliary contact for an "ON" signal to the remote fuel pump and to open the solenoid in the fuel line in the generator room.

The fuel pump, fuel lines from the bulk tank to the day tank and the solenoid in the fuel line shall be supplied and installed under this contract.

The tank shall be fitted with a suitable filter, a full height gauge glass, "low fuel level" alarm, giving an audible and visible signal on the switchboard as well as a low-low fuel level cut-out.

ESGS6.5.3 Fuel Lines

The fuel lines to and from the engine shall be done in black steel piping. A fusible link shall be supplied in each fuel line together with an automatic fuel shut-off valve.

ESGS6.5.4 Fuel Filter and Water Trap

Apart from the engine-moulded filter, a combined fuel filter and water trap shall be installed in every fuel line to the engine.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ESGS6.6 Governor

- Electronic governor to be equal and similar to the American Bosch Governor equipment and to meet the requirements of BS ISO 3046 for Class A2 electronic governors.
- The Governor shall make use of the engine starting battery as auxiliary power source.
- The permanent speed variation between no load and full load shall not exceed 4,5% of the normal engine speed and the temporary speed variation shall not exceed 10% External facilities must be provided on the engine, to adjust the normal speed setting by $\pm 5\%$ at all loads zero and rated load.

ESGS6.7 Flywheel

A suitable flywheel must be fitted, so that lights fed from the set will be free from any visible flicker.

The cyclic irregularity of the set must be within the limits laid down in BS ISO 3046.

ESGS6.8 Exhaust Pipe and Silencer

It is essential to keep the noise level as low as possible. An effective exhaust silencing system of the residential type must be provided.

In a building environment the exhaust pipe shall exit through the wall, with the pipe being fixed in or to the wall. The exhaust pipe must be flexibly connected to the engine to take up vibrations transmitted from the engine, which may cause breakage. Any flexibility as may be required shall be provided near the engine.

The exhaust piping and silencer shall be lagged to reduce the heat and noise transmission into the plant room and shall be protected against the ingress of driving rain at 45° to the horizontal. The exhaust pipe must extend 0,5m above the roof gutters. It must be secured by flanges both sides of the wall at the point of exit. These flanges must be clamped to the wall with bolts through the wall.

The exhaust pipe shall be stainless steel.

All asbestos fibre lagging shall be over wrapped by metallic tape to prevent fibre loss.

All exhaust gas ducting and silencing shall be provided with the engine, to suit the layout shown on the drawings, with all passages through wall apertures neatly finished with architraves or flashing supplied and installed by the Contractor.

For air-cooled engines, the exhaust gas ducting shall preferably be inside the exhaust air ducting, which shall be of non-heat conductive material as far as possible and fully lagged. Exhaust air and gas ducting shall be sufficiently robust to preclude deterioration due to operating vibration.

ESGS6.9 Accessories

The engine must be supplied complete with all accessories, air and oil filters, 3 instruction manuals, spare parts lists, the first fill of all lubricating oils, fuel, etc.

ESGS7 ALTERNATOR

The alternator shall be of the type and construction having the following characteristics:

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- Self-excited brush less type, with enclosed ventilated drip proof housing and must be capable of supplying the specified output continuously with a temperature rise not exceeding the limits laid down in BS 5000 for rotor and stator windings.
- 400/230V, 3 phase, 50 Hz, star connected with neutral brought out for solid earthing.
- Continuous running duty class S1.
- Full load plus 20% minimum continuous rating at a power factor of 0,8 and an one hour overload rating; the ratings to match the engine continuous and overload ratings at site.
- Protection class IP21 and cooling method ICO1.
- Self-exciting with automatic voltage regulation as specified separately.
- Anti-condensation heaters shall be provided in the generator windings.
- Class F rotor insulation.
- Class B or F stator insulation but temperature rise limits to 80°C by resistance method.
- Both ends of all three windings brought out to dry type terminal boxes which allow phase and neutral connections to be made by means of suitably sized 1000V cables/bus bars and also for a star point to be created within the box.
- Both windings must be fully impregnated for tropical climate and must have an oil resisting finishing varnish.

ESGS7.1 Regulation

The alternator must preferably be self-regulated without the utilisation of solid-state elements. The inherent voltage regulation must not exceed 5% of the nominal voltage specified, at all loads with the power factor between unity and 0,8 lagging and within the driving speed variations of 4,5% between no-load and full load.

ESGS7.2 Performance

The excitation system shall be designed to promote rapid voltage recovery following the sudden application of the load. The voltage shall recover to within 5% of the steady state within 300 milliseconds following the application of full load and the transient voltage dip shall not exceed 18%.

ESGS7.3 Coupling

The engine and alternator must be directly coupled by means of a high-quality flexible coupling, equal and similar to the "HOLSET" type.

ESGS7.4 Alternator Controls

The following alternator set controls shall be supplied and moulded together with the protection devices:

- Voltage setting device.
- Governor setting device to set frequency.
- Frequency meter.
- Combined instantaneous and thermal maximum demand kVA meter.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Power factor meter.
- Running hour meter.

ESGS7.5 Diesel Alternator Set Protection

The diesel alternator set shall be provided with protection devices for the following conditions:

- Low water level.
- High temperature.
- Low oil pressure.
- Over-speed.
- Under-speed.
- Low fuel level (audible and visual alarm shall be provided when the day tank is half and shall stop the engine just before the day tank is empty).

These occurrences shall cause the engine to stop and in addition voltage free contacts shall be provided to trip the associated alternator circuit breaker.

The over-speed protection shall operate in such a way that the engine is stopped even though it may still be supplied with fuel.

An indication shall be retained by each of these fault conditions. The indication shall be cancelled by a reset pushbutton after the initiating device has reset.

The above protection devices shall preferably be of the solid state, plugged-in modular type.

In addition to the above protection devices for the engine the following protective relays shall be supplied and installed for the generator:

- 3 Phase over-current protection relay.
- An instantaneous restricted earth-fault relay. Suitably rated Current transformers must be supplied and installed in the phase and neutral conductors. If necessary, a timer must be installed to ensure stability under switching transients.
- An over-voltage relay with an additional 0,2-10 sec's timer if necessary.

Tenderers shall satisfy themselves of the suitability, stability and sensitivity of the required scheme. Tenderers shall furthermore supply any additional protection they consider necessary.

ESGS7.6 Excitation and Voltage Regulation

Tenderers must allow for auxiliary equipment and instruments for the complete A.V.R. and excitation system. Full details of the system must be submitted with every Tender.

ESGS8 CONTROL PANEL FOR STANDBY GENERATOR SET

ESGS8.1 General Details

A control cubicle shall be provided for the generator set and it shall house all the electrical equipment associated with starting and stopping of the set, protection of the set, indications and the circuit breakers, contactors and switches controlling the outgoing power circuit and starting battery charger.

ESGS8.2 Cubicle Construction

The control cubicle shall be a separate totally enclosed, floor-mounting unit of rigid sheet metal construction with hinged or removable panels on a rigid channel iron base frame. The cubicle shall be large enough for adequately housing the specified equipment with sufficient electrical clearances and space to make cable terminations and facilitate easy replacement of and maintenance to equipment.

The cubicle shall be constructed with neatly rounded corners and all equipment shall be mounted behind the front panel on sub panels in such a way that only operating handles and instrument faces protrude.

The cubicle steelwork shall be thoroughly cleaned after fabrication, primed with a high quality zinc chromate primer and finished with two coats of baked enamel. The final colour shall be admiralty grey, no. G35 to SANS 1091.

All exposed hinges, catch mechanisms, bolts, screws, etc., shall be chromed. Self-tapping screws shall not be used anywhere on the cubicle.

The cubicle of external cable terminations shall be of the rail mounted clamp type and not less than 8mm wide. All metal components of the terminals shall be of a type that will not allow screws to work loose with vibration.

The set shall be operated as an automatic standby set or as a manually operated pushbutton start standby set, as specified in the Project Specification.

ESGS8.3 Power Control Equipment

The following equipment shall be provided in the power circuit:

- a) One 3-pole main switch (SW1).
- b) One 3-pole generator contactor (C1).
- c) One 3-pole moulded case circuit breaker with shunt and over current trips generator protection (CB1).

The circuit breaker over current tripping curve shall have an inverse time characteristic to prevent spurious tripping on momentary overloads but shall be fast enough to disconnect the alternator before any damage is sustained in the events of short circuit or unallowable sustained overload.

A core balance relay embracing line and neutral connections to the alternator shall be provided and shall operate on the shunt trip coil of the circuit breaker. The core balance relay shall also have an inverse characteristic, and its sensitivity shall be such as to prevent serious lamination damage in the event of an internal winding to earth fault.

Only the coils of contactor C1 and the shunt trip coil of CB1 and their current paths shall operate on 220V AC. C1 shall be complete with auxiliary switches as may be required in the control circuits.

- a) One voltmeter with selector switch and three fuses.
- b) One frequency indicator.
- c) Three current transformer operated ampere meters with instantaneous, immediate past half hour maximum demand and resettable highest past half hour maximum demand indicators, transformers for meters and built-in saturating current transformers for meter protection.
- d) One 3-pole 15kA moulded case circuit breaker for feedback to the main distribution board (CB2).

All the power control equipment operating at 380/220 V including connections, except the contactor control relays, shall be housed in a compartment separate from the one housing the control equipment which will operate at starting battery voltage.

ESGS8.4 Communication Module

An Ethernet communication module shall be supplied for remote monitoring and control of the standby generator set. All available parameters of the standby generator set shall be displayed on the SCADA system.

ESGS8.5 Alarm Equipment

Three alarm lights are required to indicate the following:

- Start failure.
- Engine faults.
- Fuel shortage.

These lights are to be turned off when acknowledged on a push button or toggle switch on the panel. An alarm hooter shall also sound on any of these failures and shall be turned off by acknowledgement on a separate push button or toggle switch.

ESGS8.6 Instruments

Indicating instruments shall be as far as possible of the same size and appearance with a scale length of approximately 90 mm and Class 1.5 accuracy.

ESGS8.7 Generating Set Control Equipment

The generating set control and protection equipment shall operate on a supply derived from the starting battery except the control current paths for CB1 and C1.

The control circuitry for the generating set shall be designed to suit automatic standby duty and a three phase mains monitoring relay shall be provided for controlling the starting and stopping of the set and change-over of the mains and generator contactors.

The normal (automatic) operation of the set shall be as follows:

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- SW1 and CB1 must be on and if this condition is not fulfilled then start-up must be inhibited.

On receipt of a mains failed signal, the starting cycle shall be initiated. The starting cycle shall be locked out after three failures to start, and an alarm sounded with the relevant alarm light lit.

ESGS8.8 Normal Start-Up

In case of start-up, contactor C1 shall be closed only if the following conditions have been fulfilled:

- a) The speed (frequency) is within acceptable limits.
- b) The voltage is within acceptable limits.
- c) A period of 10 seconds has elapsed after start-up.

ESGS8.9 Normal Shutdown

Normal shutdown of the set shall be initiated by removal of the start signal. C1 shall open if mains power becomes available.

The opening of C1 shall initiate a timer set to 5 min. after which period the engine shall be stopped, provided also that the starting battery is in fully charged condition. The time delay is to provide a cooling down period at no load as well as to prevent cycling during short power restorations.

ESGS8.10 Test running

For test running of the set a key operated switch shall be provided which when operated will simulate a power failure and cause the set to start. The key shall be trapped in this position.

When returned to normal the set shall be caused to stop in the normal manner. Whether the set is tested on load or off load shall depend on the position on SW1. Initially, testing the set this way will always result in an off load test.

ESGS9 CABLING TERMINATIONS AND DUCTING

All the necessary ducts for cabling and piping must be made available under this contract.

The Contractor shall supply and install all the control cabling and wiring necessary for the complete installation.

The power cables/bus bars between the alternator and the circuit breaker on the Control panel shall be suitably sized and shall all be supplied and installed under this Contract.

ESGS9.1 Small Wiring

Small wiring shall be done in P.V.C. insulated conductors of the following types:

- Flexible conductors of not less than 2,5 mm² of 300/500V grade to table M of SANS. 1507.
- Seven strand conductor of not less than 2,5 mm² or otherwise in compliance with SANS. 1507 for 600/1000V grade cores

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESGS9.2 Low Voltage and Multicore Cabling

The conductors shall be of high conductivity copper insulated with one layer of P.V.C.

The colour of the cores of 2, 3 and 4 core cables shall be as follows:

- TWIN CORE: ONE RED AND ONE BLACK
- THREE CORE: ONE RED, ONE WHITE AND ONE BLUE
- THREE CORE (SINGLE PHASE): ONE RED, ONE BLACK AND ONE GREEN/YELLOW.
- FOUR CORE: ONE RED, ONE WHITE, ONE BLUE AND ONE BLACK

The cores of cables with more than four cores may be coloured or numbered.

The cores are to be twisted together, bedded, and sheathed with P.V.C. (preferably black) armoured with a layer of galvanised steel wire, bedded and served with black P.V.C.

All insulation shall be for general service 1 000 volt grade.

The cable is to be in accordance with SANS 1507.

Cables with cores of less than 4 mm² area shall not be used.

ESGS9.3 Terminals

Terminals may be of the stud type otherwise of the rail moulded clamp type. All types together with their insulation shall have a minimum comparative creep index of 500.

Stud type terminals shall be of a type which cannot rotate in their insulation. Studs shall be of brass of not less than 6 mm dia. brass.

Studs shall not carry current through the insulation.

Not more than two connections per terminal shall be made. Locknuts or spring washers shall be used to prevent loosening of connections with vibration.

Terminals carrying voltages over 42 volts shall be protected by insulation.

Clamp type terminals shall be at least 8 mm wide.

Screws and clamps shall be plated against corrosion and screws shall be self-locking type unaffected by vibration.

Current carrying parts shall be of copper or brass, grooved and silver plated.

Only one connection per terminal entry may be made. For more connections more terminals with central bridge pieces shall be used.

ESGS9.4 Marking of Wiring and Cable Ends

All small wiring and cable ends shall be marked in accordance with the requirements of The Particular Specification for Cables. Marking ferrules shall be prevented from coming off the conductor ends by the terminal lugs.

ESGS9.5 Termination of Wiring and Cable Ends

All wiring and cable ends shall be terminated with proper cable lugs entirely suitable for the type of terminal.

ESGS9.6 Glands for PVC-SWA Cable

Glands shall be of the adjustable type, and shall be suitable for PVC SWA PVC general purpose 1 000 Volt cable.

The non-watertight glands must be easily converted to watertight glands by means of a waterproofing shroud.

The glands are to be made of copper plated and heavily tinned bronze or brass, and shall consist of a barrel, with a cone nut carrying a cone bush screwed into one end and a hot tinned steel nipple carrying a heavy galvanized steel lock nut screwed into the other end.

On the cable entrance side of the barrel, a round groove shall be provided, for taking the top rim of the waterproofing shroud.

The shrouds are to be made of non-deteriorating neoprene or synthetic rubber, and shall be resistant to water, oil and sunlight. The shrouds shall tightly fit around the glands and cable.

ESGS10 General

ESGS101 Painting and Corrosion Protection

The Contractor shall give full details in the TECHNICAL SCHEDULE of the painting system he proposes. The colour of finishing coats shall conform to SABS 0140: PART II.

EGS10.2 Markings and Labels

The standard nameplates of manufacturers giving information on manufacturer type, class, rating etc., will be accepted unaltered.

All controls related to the starting, stopping and running of the plant and all alarms shall be properly marked with plastic labels engraved with contrasting characters in both Afrikaans and English. Characters shall not be less than 4 mm high.

Labels shall be fixed with chrome-plated screws. The wording of all labels, nameplates excluded, shall be submitted for approval.

ESGS10.3 Identification

Engines are to be provided with a substantial information plate fastened securely to the engine in an easily visible position.

The plate must be clearly and indelibly marked (i.e. painted lettering is not adequate), showing at least the following data:

- Manufacturer's name, engine model and serial number.
- Contract number.
- Supply agency.

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Contractor

Witness 1

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Employer

Witness 1

Witness 2

- d) Country of origin where not manufactured locally.
- e) Year of manufacture.
- f) Capacity of engine.
- g) Sea level rating at nominal ambient conditions.
- h) Site rating.
- i) Mass of engine complete.
- j) Type of lubricating oil to be used.

ESGS10.4 Spares

Tenderers must submit a priced list of recommended spares to be kept in stock by the Client.

ESGS10.5 Noise

The noise level of the complete unit, (engine and driven load) shall be kept to an intensity less than 84db(A) at 0,5 m, in the open.

The Contractor shall be responsible for achieving this sound level and shall give full details in the TECHNICAL SCHEDULE of any insulation he proposes to install in order to achieve this level.

ESGS11 HANDLING

Engines shall be closed crated for transporting to Site, with crating fully adequate for the protection of all parts from impact damage and from dust or grit ingress.

Where it is necessary for engines to be stored either at the place of manufacture or supply, or at the Site, they shall be stored under cover and guarded against excessive moisture or windblown dust or grit.

Engines shall be stored on timbers to raise them off the ground, and all inlets and outlets shall be adequately sealed.

ESGS12 INSTALLATION

Installation on Site shall only be carried out by competent workmen under experienced supervision. Site fabrication, if any, shall be done in a workmanlike manner without damage to other sections of the Works.

ESGS13 COMMISSIONING

Commissioning of the engines shall be done in the presence of the Engineer. Commissioning shall comprise the checking of each function of each accessory to the engine as well as a 2-hour duration running of the engine, under load if feasible, to ensure consistent oil pressure and temperature.

ESGS13.1 Instruction of Attendant(S)

During commissioning of the set, and after, if necessary, the Contractor shall instruct an attendant or attendants in the operation of the plant until he/they is/are fully conversant with the operation and maintenance of the plant.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ESGS14 TESTS

The following tests shall be done by the Contractor in the presence of the engineer and the client.

- Factory test reports
- Field test reports and other documentation including a description of the test procedures and inspections with results listed for each test performed in a type-written format. Include results of tests, inspections and retests.

The following tests shall be done by the Contractor in the presence of the client.

ESGS14.1 Works Tests

Before delivery to site as many of the tests possible in accordance with BS ISO 3046 shall be done at the manufacturer's works. Tenderers shall state what load tests can be done at their works. If proper load tests and sudden application and rejection of loads cannot be done, to prove governor and A.V.R. responses, then these will have to be done after installation at site.

Stripping of engines after testing will not be required.

The Contractor shall supply the fuel required for works tests.

Sufficient notice shall be given to the client of the proposed testing date(s).

ESGS14.2 Site Tests

After completion of the installations site tests shall be done to prove the correct function of all controls and protection.

Generators shall be dried out by running the sets and circulating full load current on short circuit and taking insulation resistance/time curves.

Tests shall be done to prove correct functioning of all controls, protection and synchronising.

Fuel consumption tests shall be done. These tests shall be done at full, three quarter and half load. (A dummy load must be provided for full load tests by the Contractor).

If called for by the Client a twenty-four-hour test shall be carried out at full load with a 10% overload for 1 hour in every 12-hour period. Afterwards curves shall be drawn of all the variable parameters such as speed, temperature, oil pressure, fuel consumption, etc.

ESGS15 GUARANTEE AND MAINTENANCE

The Contractor shall guarantee and do the normal maintenance for the complete plant for a period of twelve months from the date it has been taken over by the Client in good running order.

ESGS16 DOCUMENTATION

ESGS16.1 Drawings Accompanying Tenders

Drawings shall be submitted with all Tenders to show the general appearance of main equipment offered. Salient dimensions only are required on such drawings.

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ESGS16.2 Contract Drawings

Within two months after the commencement date of the Contract, the Contractor shall submit duplicate paper prints of general arrangement drawings and circuit diagrams to the client for approval. Drawings to be revised shall be re-submitted until final approval is obtained.

After approval four further paper prints shall be supplied.

A transparent print of each approved drawing on film shall be supplied when so requested by the client.

Drawings shall only be done on A1 size of sheets with the long sides of the sheets orientated horizontally.

This will facilitate the eventual binding of Engineer's and Supplier's drawings in one volume.

Drawings shall be done in accordance with the requirements off the specifications.

General arrangement drawings shall show front and side elevations together with salient dimensions and the positions of fixing holes and external connections as well as clearances or space required for withdrawal or lifting of major pieces of equipment for servicing or maintenance purposes. The layout of instrument and control panels shall also be shown.

Diagrams, and the symbols used shall be in compliance with the requirements of B.S. 3939.

In circuit diagrams preference shall be given to showing a circuit element in its correct electrical position in the current path rather than attempting to keep all the elements of a device together. A current path shall be drawn as far as possible in a straight line and crossing of different current paths shall be avoided as far as possible. In this connection refer to B.S. 3939: Introduction Page 11 and also B.S. 3939: Guiding Principles, Clause H3 and N3.

Wiring diagrams for switchgear are not required.

Diagrams showing cable connections between units of an installation shall be supplied.

ESGS16.3 Handbooks

Handbooks shall contain complete information on the following aspects of all units comprising a working installation:

- Technical descriptions and specifications of equipment.
- Erection and commissioning instructions.
- Operating instructions.
- Description of functioning, adjustment and maintenance of equipment.
- Parts lists, with illustrations where necessary, for ordering of replacements.

ESGS17 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

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ESGS17.1 Supply and Delivery to Site

	Pay Item	Unit
a)	Supply and delivery to site of complete Standby generator set as specified	Sum
b)	Supply and delivery to site of complete automatic mains failure Start-up system as specified	Sum
c)	Supply and delivery to site of complete automatic change over system as specified	Sum
d)	Supply and delivery to site of complete sound attenuation enclosure as specified	Sum
e)	Supply and delivery to site of complete fuel tank complete with mounting frame	Sum

ESGS17.2 Installation

	Pay Item	Unit
a)	Installation of complete Standby generator set as specified	Sum
b)	Installation of complete automatic mains failure Start-up system as specified	Sum
c)	Installation of complete automatic change over system as specified	Sum
d)	Installation of complete sound attenuation enclosure as specified	Sum
e)	Installation of complete fuel tank complete with mounting frame	Sum

ESGS17.3 Commissioning

	Pay Item	Unit
a)	Commissioning of complete Standby generator set as specified	Sum
b)	Commissioning of complete automatic mains failure Start-up system as specified	Sum
c)	Commissioning of complete automatic change over system as specified	Sum
d)	Commissioning of complete sound attenuation enclosure as specified	Sum
e)	Commissioning of complete fuel tank complete with mounting frame	Sum

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PORTION 2: CONTRACT

PART C3.4: CONSTRUCTION

Section C3.4.4 Particular Specifications

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



C3.4.4 PARTICULAR SPECIFICATIONS

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PLK: MANUFACTURE AND SUPPLY OF VALVES

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PLK 1 SCOPE

This section of the Specification includes the manufacture, testing and supply of valves for the conveyance of raw or potable water at ambient temperatures in pipes under pressure.

PLK 2 STANDARDS

The most recent issues of the following standard specifications will apply for the purposes of this Specification.

SANS 144	:	Cast-iron single door non-return valves
SANS 191	:	Cast steel gate valves
SANS 192	:	Cast steel single door non-return valves
SANS 664	:	Cast iron gate valves for waterworks
SANS 665	:	Cast iron gate valves for general purposes
BS 5155	:	Cast iron and carbon steel Butterfly valves
ISO 2441	:	Pipeline flanges for general use shapes and dimensions of pressure tight surfaces
SANS 1123	:	Steel pipe flanges
SIS 05 5900	:	Pictorial surface preparation standard for painting steel surfaces

PLK 3 MATERIALS

PLK 3.1 Sluice Valves

- PLK 3.1.1 The valve body, bonnet, thrust dome, gate and glands shall be of cast iron or cast steel as specified and depending on the required test pressures.
- PLK 3.1.2 The stuffing box shall be of ample depth to afford sufficient space for long period packing and the design shall be such as to allow the gland to be easily and conveniently repacked under pressure.
- PLK 3.1.3 Body and gate sealing rings shall be of bronze, gunmetal or stainless steel. RSV gate shall be nitrile rubber covered and fully encapsulated. The rubber shall not be removed from the guides of the gate.
- PLK 3.1.3 Spindles shall be of high grade stainless steel.
- PLK 3.1.4 An isolating valve must be able to check the specified water pressure from both sides.

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PLK 3.2 Butterfly Valves

- PLK 3.2.1 Valve bodies and discs shall be of high-grade cast-iron or cast steel as specified and depending on the required test pressures.
- PLK 3.2.2 The disc shaft or stub-shafts shall be of stainless steel located in self-lubricating bearings.
- PLK 3.2.3 Sealing rings, seal retaining rings, body seatrings and associated screws shall be of stainless steel.
- PLK 3.2.4 A butterfly valve must be able to check the specified water pressure from both sides.

PLK 3.3 Reflux Valves

- PLK 3.3.1 Valve bodies shall be of cast iron or cast steel depending on the specification or test pressures.
- PLK 3.3.2 Valve doors shall be of cast iron or cast steel.
- PLK 3.3.3 The valve body and doors or disc shall be fitted with replaceable stainless steel body and door seat rings.

PLK 3.4 Air Valves

PLK 3.4.1 Function

Air valves are required to perform any combination of the following functions:

- Uninterrupted high volume air discharge through a large orifice during pipe filling.
- Uninterrupted high volume air intake through a large orifice during pipe emptying.
- Discharge of pressurised air through a small orifice during normal operation.
- Surge alleviation mechanism during rapid air discharge or rejoining of separated water columns.

PLK 3.4.2 Closing mechanism, construction and design

- PLK 3.4.2.1 The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. Floats of spherical design shall not be accepted. Any hollow float design will not be acceptable due to implosion and distortion making sealing difficult or impossible.
- PLK 3.4.2.2 The ends of the cylinder shall be of fusion bonded epoxy powder coated mild steel, secured by means of stainless steel tie rods.

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PLK 3.4.2.3 Floats shall be housed in a tubular stainless steel or corrosion protected body, secured by means of stainless steel fasteners.

PLK 3.4.2.4 The seats, spindles, guides, etc shall be of a suitable non-corroding metal with sufficient clearance and shall be designed to prevent abrasion of the ball or float when subjected to frequent operation.

PLK 3.4.2.5 The seats of the orifices shall not have sharp edges and shall be designed so as not to damage the ball or float when subjected to pressure.

PLK 3.4.2.6 The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns.

The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure.

Relief mechanisms that act subsequent to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.

The performance capability of an integral surge alleviation mechanism shall be substantiated through third party testing, conducted by a recognized authority.

PLK 3.4.2.7 Large orifice sealing shall be effected by the flat force of the control float seating against a nitrile rubber 'O' Ring housed in a dovetail groove circumferentially surrounding the large orifice.

Sealing in any other form shall not be accepted due to the vulcanizing of the float or the wedging of the float in the large orifice.

PLK 3.4.2.8 Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

Valves with slotted air release apertures shall not be considered.

PLK 3.4.2.9 The intake/discharge orifice area shall be equal to the nominal size of the valve i.e. a 200 mm valve shall have a 200 mm intake/discharge orifice.

Valves up to and including 200mm NB shall incorporate an over pressure safety feature that will fail without an explosive effect, such as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

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PLK 3.4.2.10 The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to 2 times the designed working pressure.

PLK 3.4.3 Testing

PLK 3.4.3.1 Manufacturers' published performance data must be substantiated by third party testing from a recognized test authority.

PLK 3.4.3.2 A high pressure strength and leak test whereby the valve is filled with water and pressurized to 2 times the rated working pressure which shall be held for a period of 2 minutes. Any leaking, weeping and sweating shall be a reason for rejection. These tests must be on total, completed units including floats.

PLK 3.4.3.3 Any imported valves shall be retested locally in all areas of specification.

PLK 3.4.4 Isolating valves for air valves

PLK 3.4.4.1 Each air valve shall be provided with a suitable double flanged resilient seal gate valve to isolate the air valve from the main.

PLK 3.4.4.2 The isolating valves shall be capable of operating in a horizontal position and shall be provided with a handwheel for operation and gearing is not required.

PLK 3.4.4.3 Each isolating valve shall be provided with a handwheel fitted to the spindle in an approved manner and shall have directional indication so cast into a recess on the upper surface of the rim that the top of the letter, arrows and rim are at the same level.

PLK 3.4.5 Drains

PLK 3.4.5.1 All air valves be provided with drain cocks so that the body of the valve can be drained when isolated from the pipeline. Cast steel gate valves shall be provided for this purpose.

PLK 3.4.6 Pressure gauge fitting

PLK 3.4.6.1 A 12-mm cast steel full bore gate valve shall be fitted to the spool piece between the isolating valve and the air valve flanges for attaching a pressure gauge.

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PLK 3.5 Ring needle valves

- PLK 3.5.1 The valve body shall be of spheroidal graphite iron or cast-steel with supporting feet. The body seat shall be of stainless steel and shall be replaceable or may be deposit welded on a removable body section.
- PLK 3.5.2 For ring needle valves the piston (plunger) shall be of cast stainless steel with replaceable resilient seal to obtain drop tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws.
- PLK 3.5.3 For spherical ball valves, the eccentrically supported ball plug shall be of cast stainless steel or spheroidal graphite iron with replaceable resilient seal to obtain drop-tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws. The valve body shall include an access door to permit adjustment or replacement of the valve seal without dismantling the valve.

PLK 3.6 Manufacture

PLK 3.6.1 General

- PLK 3.6.1.1 The design pressure of the valves shall not be less than the pressure specified subject to a minimum of 1 000 kPa.
- PLK 3.6.1.2 All valves shall be double-flanged with bolt holes drilled off-centre all in accordance with the requirements of SANS 1123 or as otherwise specified.
- PLK 3.6.1.3 The Tenderer shall give as a function of the downstream pressure the maximum acceptable discharge of water through the valves without risks of vibration and cavitation. The Tenderer shall also submit the head-loss characteristics of the valves.
- PLK 3.6.1.4 The design pressure will be hand stamped on the top edge of the flanges of valves in kPa.
- PLK 3.6.1.5 If specified, valves shall be supplied with by-passes to be bolted on to the body of the valve and not to the adjoining pipework.
- PLK 3.6.1.6 Valves shall be fitted with position indicators if specified. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators.
- PLK 3.6.1.7 Arrows shall be cast on all handwheels together with the wording "OPEN" or "CLOSE". The closing direction shall be clockwise unless otherwise specified.

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In the case of cap top valves, an aluminium disc of at least 100 mm diameter and with the same wording and arrows shall be slipped over the spindle and retained by the cap.

PLK 3.6.1.8 All valves shall be supplied complete including bolts, nuts, washers and gaskets in accordance with the class of valve. Bolts shall be of sufficient length to allow not more than three screw threads to protrude outside units after complete tightening of the assembly. Gaskets for flanged joints shall be of compressed asbestos fibre to BS 2815 Grade A and full faced with a minimum thickness of 3 mm for pressures up to and including 1 600 kPa cloth-inserted rubber may be used.

PLK 3.6.1.9 Where isolating valves are required to be equipped with extended off-set spindles, the spindles shall be equipped with sufficient universal joints to ensure satisfactory valve operation. All spindle extensions shall be secured to permanent structures with galvanised clamps to the Engineer's approval. The rate for such valve items shall include for any required clamps, extensions joint, etc.

Handwheels on such extended spindles shall be mounted on plain-ended spindle or handwheel pedestal as specified or indicated on the construction drawings.

Isolating valve operation:

Cap top	CT
Handwheel	HW
Electric actuator	EA
Pneumatic actuator	PA
Handwheel spindle extension	HSE
Plain ended spindle extension	PESE
Platform-mounted handwheel pedestal	PMP
Handwheel pedestal on wall support bracket	HPWB
Stub handwheel pedestal on wall support bracket	SHWB
Grid-mounted handwheel pedestal	GMP

PLK 3.6.1.10 The following information shall accompany the tender:

- Description
- Flange Drilling
- Maximum working pressure
- Maximum unbalanced pressure
- Test pressure
- Manufacturers number
- Material of components
- Gearing

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- Accessories

PLK 3.6.2 Sluice Valves

- PLK 3.6.2.1 Double-flanged, wedge-gate, internal (non-rising) spindle sluice valves of the waterworks pattern are required to comply fully with SANS 191 or SANS 664 where applicable.
- PLK 3.6.2.2 Only full-way valves will be accepted (i.e. the gate must be clear of the waterway in the fully open position).
- PLK 3.6.2.3 The maximum force required to turn the handwheel at the maximum torque shall not be greater than 100 N per hand at the handwheel run (Total effort = 200 N) when operating at an unbalanced pressure equal to the rated working pressure of the valve. This may be achieved with the aid of gearing of a suitable ratio.

Where gears are used replaceable shear pins shall be provided to prevent damage to the valve if excessive pressure is used.

PLK 3.6.3 Butterfly Valves

- PLK 3.6.3.1 Horizontal spindle type butterfly valves complete with gearing, handwheels and flanged at both ends with separate bolting for joining to the adjacent pipework is required.
- PLK 3.6.3.2 All butterfly valves shall be double eccentric / offset type.
- PLK 3.6.3.3 Wafer valves or valves fitted with studs for attachment to the adjacent flanges are not permitted.
- PLK 3.6.3.4 Valves shall be drop-tight when closed and metal to metal sealing is not acceptable.
- PLK 3.6.3.5 All resilient seals shall be removable and readily replaceable on Site with the valve in position.
- PLK 3.6.3.6 Resilient seals shall be retained by corrosion resistant securing elements to prevent corroding in position (e.g. bolts, set screws, etc.)
- PLK 3.6.3.7 The valvewater seal shall be of the following types:
- a resilient seal fixed to the edge of the disc by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the body.
 - a resilient seal fixed to the body of the valve by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the edge of the discs.

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PLK 3.6.4 Reflux Valves

- PLK 3.6.4.1 Reflux valves shall be double-flanged, SANS 1551.
- PLK 3.6.4.2 Valve bodies and seals shall be free of pockets that will allow dirt accumulation and prevent the doors from closing fully.
- PLK 3.6.4.3 Stops or an approved resilient material shall be fitted into the body to prevent the doors from fluttering under full flow conditions.
- PLK 3.6.4.4 Valves shall be designed to allow for rapid but non-slamming closing characteristics.

PLK 3.6.5 Air Valves

- PLK 3.6.5.1 Air valves shall be supplied with double-flanged, wedgegate internal (non-rising) spindle sluice valves for isolation, which unless otherwise specified shall conform in all respects to this specification.

PLK 3.6.6 Ring needle valves

- PLK 3.6.6.1 Ring needle valves used as auto closing valves shall fulfil the following functions:
- Electrical operation (isolating and control) suitable for opening and closing against the specified pressure and for continuous operation in any intermediate position.
 - Automatic as well as manual mode control.
 - Automatic reflux action for quick closure by means of drop-weight and hydraulic dash pot in case of power failure or motor protective tripping.
 - Adjustable closing time and adjustable closing characteristic.
- PLK 3.6.6.2 The totally enclosed flanged-on gearbox shall include the following:
- Either an electro-mechanical unit comprising:
 - a totally enclosed brushless electromagnetic gear clutch for quick closing;
 - a totally enclosed directly mounted electric valve actuator with integral electric controls and auxiliary handwheel for manual operation;
 - or an electro-hydraulic unit comprising:
 - an oil hydraulic lift cylinder for opening the valve;
 - a totally enclosed directly mounted electronic driven oil pump and oil reservoir. The oil pump and reservoir may be individually mounted on each valve or a centralised system may be employed to feed more than one valve and/or pumpline;

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- a solenoid operated hydraulic control valve which shall be de-energised to initiate closure of the valve.

PLK 3.6.6.3 Either of the above actuators shall also be provided with:

- limit switches for signalling the “open”, “closed” and intermediate “10%” positions and further control functions as required;
- a directly mounted oil hydraulic dashpot with the necessary control valves for adjusting closing time and operating characteristic;
- means to operate the valve manually;
- valve shaft (stub shafts) of high tensile stainless steel located in bushes of zinc-free bronze;
- a drop weight lever arm of steel with adjustable cast iron drop weight. The lever arm shall be keyed or splined to the shaft.

PLK 3.6.6.4 The overhang shaft carrying the drop weight lever arm shall be supported at its bearing housing from the foundation block.

PLK 3.6.6.5 Travel of the drop weight shall be restrained for reasons of safety at either end of the lever arm.

PLK 3.6.6.6 The control valves shall be arranged for selection of either manual-electric or automatic-electric operation controlled from the pump control console. Push buttons “open”, “close” and “stop” for piloting these valves, when throttling is required, shall be incorporated in each pump control console, as well as indicator lamps showing “closed” (green) “intermediate” (amber) “open” (red) positions. In addition, a selector switch “manual/automatic” shall be incorporated, the automatic position being in conjunction with pump starting. A further “test” selector switch shall be mounted inside the panel to permit manual-electric testing of the equipment without running the pumpset.

PLK 3.6.6.7 In the “automatic” mode the valve shall open automatically from the fully closed to fully open position when the pumpset is started, likewise closing automatically, when the pumpset is to be shut down. In the “manual” mode the valve shall open automatically to at least the “10% open” intermediate position, whereafter manual selection of the valve position shall be enabled.

- Each valve shall be interlocked with the pump starter. When the pump is to be stopped, the valve shall close slowly to prevent water hammer either by means of the electric actuator or by releasing hydraulic pressure in the lift cylinder by means of control valves before the pumpset is tripped and stopped by interlocked relays.
- Similarly, the valve shall be arranged so that the pump can be started only when the valve is fully closed. The valve shall open only when the starting operation is completed and the motor is up to speed.

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PLK 3.6.6.8 The control valves shall have automatic reflux action features to close by drop-weight, controlled by an oil hydraulic dashpot, in the event of power failure or motor protective tripping. The drop-weight shall be released by a solenoid operated clutch or a valve which is constantly energised during pumping operations. Closing time and characteristics shall be adjustable to minimise water hammer.

PLK 3.6.6.9 It shall be possible to energise the “manual” mode only when:

- the associated pump is running.
- the valve is at least 10% open as indicated by the “intermediate” lamp.
- the valve is in the “test” mode

Selection of the “manual” mode shall not affect the automatic reflux action.

When the opening of the valve has been set manually, the valve shall maintain this position in the absence of any further action.

PLK 3.6.6.10 “Test” mode: With both isolating valves closed and electrically interlocked, a test facility shall be provided to enable the maintenance personnel to manually operate the valve without the pumpset running by selection from inside the pump control console.

PLK 3.6.6.11 Valves shall be designed to operate free of cavitation in intermediate positions.

PLK 3.6.7 Electric Actuators

PLK 3.6.7.1 When specified, in the Project Specification the valves shall be fitted with electric, motor-driven flood-proof IP 68 actuators of robust design, capable of closing the valves under all unbalanced pressures.

PLK 3.6.7.2 The Tenderer shall state the maximum torque required to operate the valve in his Tender. In determining this maximum torque an allowance shall be made for any deterioration that could be expected to occur in the bearings during the life of the valve. The actuator shall be capable of transmitting twice this maximum torque without any of its components suffering permanent damage. This shall be proven to the Engineer's satisfaction by workshop tests.

PLK 3.6.7.3 The actuators shall be capable of restraining the valve in any position under all possible conditions of operation, and shall not, in any circumstances, be capable of becoming self-motorised as a result of the dynamic torque loading on the disc or plunger.

PLK 3.6.7.4 All gearing shall be manufactured in accordance with BS 436 Class C and shall be machine cut. All components requiring lubrication shall be adequately lubricated and totally enclosed flood-proof casing fabricated in cast iron and/or die cast aluminium to suit the service weather

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proof casing whether the valve is to be installed in the open or under cover. Actuators shall also be fitted with mechanical stops to prevent excessive turning and shall be provided with replaceable shear pins.

PLK 3.6.7.5 Handwheels shall be fitted to all actuators. The direction of rotation to close the valve shall be clockwise when viewed from above the end of the input shaft and from the position of operation. In addition, they shall be clearly and indelibly marked with an arrow showing the direction of closing and the words "Close" and "Toe".

PLK 3.6.7.6 Whether the valve is actuator driven or manually operated, the maximum force required to turn the handwheel at the maximum torque defined above shall not be greater than 100 N per hand at the handwheel rim. (Total effort = 200 N.) For large valves the minimum of complete revolutions of the handwheel to move the valve gate from fully open to fully closed shall not be less than 100.

PLK 3.6.7.7 All electric actuators shall be provided with reversing contactors: local and remote control shall be provided; a device making the local control non-operative shall also be provided on the relevant remote control panel.

PLK 3.6.7.8 After factory tests, the actuators shall be removed from the valve and delivered to Site in separate boxes to safeguard against damage.

PLK 3.6.8 Protection

All materials and workmanship to comply with relevant SANS Specifications.

PLK 3.6.8.1 Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 50 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP 2300 or similar) shall then be applied to give a final dry film thickness of 250 µm. Drying times between successive layers shall be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solventless epoxy paint system or a fusion bonded epoxy powder coating as specified in the Project Specification.

PLK 3.6.8.2 External Protection

External surfaces of valve bodies shall be wire brushed to a A 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer (dried film thickness 50 µm). This will be followed

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by two alkyd-based undercoats (each coat 25 µm thick) and one alkyd-based enamel finishing coat (dried film thickness 25 µm). Final colour will be as specified by the Engineer.

Machined flanges will be painted with a protective coating of shellac or similar.

PLK 3.7 Tolerances

Tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

PLK 4 TESTING AND INSPECTION

PLK 4.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SABS or BS Specification. These tests will not necessarily be attended by the Engineer but records must be kept and all test results shall be made available to the Engineer.

PLK 4.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. Samples required for such tests will be provided by the Manufacturer free of charge and sampling will be done by this body in accordance with the relevant SANS or BS Specification.

The cost of such control tests will be borne by the Employer.

PLK 4.3 Inspection

PLK 4.3.1 Visual, operational and dimensional inspection of valves as well as inspection of protective coatings will be carried out by the Engineer and/or the Manufacturer in the Manufacturers workshops prior to the despatch of valves to site.

PLK 4.3.2 Inspection by the Engineer shall in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

PLK 4.4 Hydrostatic Testing

PLK 4.4.1 All hydrostatic tests will be witnessed by the Engineer and the Manufacturer will give at least one week prior notification to the Engineer of the proposed dates for such tests.

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PLK 4.4.2 Valve bodies will be close end tested to at least 1,5 times the working pressure. Test pressures will be maintained for at least 5 minutes and valve bodies will be water tight in all respects at the test pressure.

PLK 4.4.3 Assembled valves will be open-end tested to 1,5 x working pressure for materials strength and soundness. Valves will be drop tight from both directions over the complete range of pressures from 0 to 1,5 x working pressure.

PLK 4.4.4 Each valve will be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

PLK 5 MEASUREMENT AND PAYMENT

PLK 5.1 General

Tendered prices shall include for the following unless otherwise specified in the Project Specification.

- Protective coatings as specified.
- Couplings and/or jointing material for each type of valve.
- Packing and temporary protection against damage during transport and delivery.
- Temporary storage and maintenance if required.
- Delivery and storage of material on site or in a store as specified.
- Testing and inspections at Manufacturer's works.

PLK 5.2 Valves will be measured per unit of each type

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PLN: MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

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PLN 1 SCOPE

This specification covers the manufacture and supply of bare, electric welded low carbon steel pipes and steel pipe special items for the conveyance of water at ambient temperatures and at medium pressures.

PLN 2 STANDARDS

Pipes and specials shall be manufactured, tested and inspected in accordance with the latest issues of the following standard specifications unless amended in subsequent clauses in this specification.

- a) Welded pipes larger than 150mm:

SANS 719: Steel Grades A, B and C

SABS 1431: Steel Grades 300 WA, 350 WA

API 5L: Steel Grades, X42, X46, X52, X56 and X60

EN 10025-2: Steel Grade S355JR + AR (where specified for specials)

- b) Welded specials and fittings smaller than or equal to 150mm:

SANS 62 (Heavy Class) up to 50 bar design pressure

- c) Seamless Pipes:

ASTM A106 – Schedule 40(40 bar) or 80(80 bar) as determined by the design pressure.

- d) Seamless specials and fittings:

ANSI B16.5 & B16.9 – Schedule as determined by the design pressure

- e) Qualifications of Welders

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified under the tests laid down in accordance with API 1104.

- f) Non-destructive Tests and Adjudication

- Radiographic inspection: API 1104
- Ultrasonic inspection: API 5L

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- g) In this Specification reference is made to the latest issues of the following specifications:
- | | |
|------|-----------|
| SANS | 719 |
| API | 5L |
| API | 1104 |
| ASME | Section V |
| BS | 2971 |
| BS | 2633 |

PLN 3 PROCESS OF MANUFACTURE FOR PIPES

PLN 3.1 Welding process

Pipes shall be manufactured by an approved semi-automatic submerged-arc welding process or shall be electric resistance welded. Where semi-automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. The number of longitudinal weld seams shall not exceed:

- a) one seam for pipes up to 1 000mm nominal diameter
- b) two seams for pipes larger than 1 000mm and up to 2 000mm nominal diameter

Circumferential welds by semi-automatic submerged-arc welding method for factory double jointed pipes shall have at least one pass on the inside and at least one pass on the outside.

PLN 3.2 Welds

SANS 719, BS 2971 and BS 2633 shall generally apply.

For fusion welded pipes and specials, the internal weld bead shall not protrude more than 1,0 mm into the bore of the pipe or special.

For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 2,0mm.

For pipes to be joined by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200mm from ends to be jointed.

For pipes to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 200mm from the end to be coupled.

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PLN 4 DIMENSIONAL REQUIREMENTS

PLN 4.1 Pipes

All dimensions shall be in accordance with SANS 719 clause 5.1 (or other relevant clause numbers in later versions) except for the following amendment to clause 5.1.3:

The wall thickness of pipe shall, subject to a tolerance of +10% or -0%, be one of the relevant values given in columns 3 to 6 of table 2, unless otherwise specified by the purchaser.

PLN 4.2 Specials

The tolerances on specials will be in accordance with BS 534, Section 4.

Unless shown otherwise, branch and manifold sections of Tees to have a common centre line and of scour tees to have a common invert line.

All dimensions on layout drawings or item details are outer face to outer face, i.e. overall.

Position dimensions for puddle flanges and restraining flange refers to centre of flanges.

PLN 5 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND AT SITE

PLN 5.1 General

Factory and site testing and inspections (quality assurance), supervision of tests and reviewing of test records shall be carried out by the Contractor.

Unless otherwise specified in the contract documents, the Contractor shall appoint an independent inspectorate ("Inspectorate") and shall be responsible for the Inspectorate's and all associated costs. The name of the Inspectorate to be submitted for the Employer /Engineer's approval. The Inspectorate will be responsible for the monitoring, witnessing and reviewing of the quality assurance plans, testing, inspections and records on behalf of the Employer / Engineer. The service provided by the Inspectorate shall not replace the duties and responsibilities of the Contractor in terms of the Contract.

All tests and inspections at the factory and on site shall be at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that will be required by the Contractor and the Inspectorate, to verify that the material complies with the Specifications. The testing facilities, instruments and equipment shall comply with the requirements of the Inspectorate.

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The Inspectorate shall be afforded every facility and opportunity during the manufacturing and testing to enable the inspection to be carried out effectively.

All test samples shall be selected by the appointed Inspectorate and all instruments used for testing purposes shall be approved by the Inspectorate and if in the opinion of the Inspectorate any instrument should require calibration, such instruments shall be calibrated at the expense of the Contractor by the SABS or such other body as may be approved by the Inspectorate.

No mechanical working or straining of pipes and specials shall be allowed after testing and inspection.

PLN 5.2 Visual Inspection

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L Section 10.2.7. In addition, welds on specials shall be inspected by the application of a penetrant-dye on the inside of the welds and no trace of the dye should appear on the outside of the pipe after completion of the test.

PLN 5.3 Non-destructive Inspection

PLN 5.3.1 Ultrasonic Inspection

The Engineers approval of a detailed method statement is required for the use of this test method prior to the start of production. When this method is used 100% of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L, Annexure E5. The equipment shall be checked with an applicable reference standard at least twice every production shift.

PLN 5.3.2 Radiographic Inspection to API 1104

Radiographic testing of welds are regarded as industry norm and shall be used unless approved otherwise by the Engineer. Test records are required to be saved in digital format. It is a requirement that 100% of longitudinal, circumferential, spiral welds and scalp welds shall be subject to radiographic inspection in accordance with API 1104, Section 9.3.

Radiographic inspection of pipes shall be as follows:

a) Longitudinal Welded Pipe

Submerged-arc fusion welded pipe, if inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 200 mm from each end of each

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length of pipe. Electric resistance welded pipes shall, however, only be inspected full length by ultra-sonic methods.

b) Spiral Welded Pipe

Submerged-arc fusion welded pipe, if also inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 100 mm from each end of each length of pipe and of the complete “H” at all skelp end welds including 150 mm of the spiral welds in both directions away from the intersection points with the skelp end welds.

c) Circumferential Butt Welds

100 percent of the length of circumferential butt welds shall be examined radiographic methods unless consistently acceptable results are obtained. Then the number of welds to be tested may be reduced by the Engineer.

d) Specials

100 percent of the length of all manual or semi-automatic welds in specials shall be examined radiographically (where possible) and all other welds by liquid penetrant testing unless consistently acceptable results are obtained. Then the number of welds to be tested may be reduced by the Engineer.

Where specials cannot be hydrostatically tested, all welds shall be liquid penetrate tested as per ASME Section V.

e) Repairs

For straight pipes 100 percent of the total length of all repairs shall be examined radiographically unless repairs are done prior to ultrasonic inspection and such repairs pass ultrasonic inspection. Then no radiographic inspection of same is required.

For pipe specials, 100% of all repairs shall be examined radiographically (where possible) and all other weld by liquid penetrant testing.

f) Pipes for rail, road and river crossings shall be examined radiographically 100 percent of the total length of all welds.

PLN 5.3.3 Liquid Penetrant Testing

All fillet welds and other welds, where requested by the Engineer, shall be liquid penetrant tested in accordance with sub-clause 7.2.1 of SANS 1200 L, clause 9.5 API 1104, ISO 10893-4 and ASTM E165.

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PLN 5.3.4 Magnetic Particle Testing

Where requested by the Engineer, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

PLN 5.4 Hydrostatic Testing

Each individual straight pipe shall be subjected to a hydrostatic test in accordance with the methods described in API 5L. Test pressures shall be such as to produce tensile fibre stresses in the pipe wall of 90% of the minimum specified yield strength of the steel or shall be 9 MPa whichever is the lesser. Leaks or sweats shall be considered injurious defects.

Should it not be possible to hydrostatically test straight piping and/or specials, the liquid penetrant test as per ASME Section V shall be done on all welds over and above the non-destructive tests specified above. This shall only be applicable with the prior written approval of the Engineer.

PLN 5.5 Repair of Injurious Defects

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L Section 10, shall be repaired in accordance with API 5L Annexure D but subject always to the requirements of this specification.

PLN 5.6 Destructive Testing

PLN 5.6.1 Type of tests

The following destructive tests shall be performed in accordance with SANS 719 clause 6.2 on the first pipe and thereafter on one pipe of every 500 subsequent pipes.

- a) Transverse Tensile Test
- b) Root Bent Test (Electric Fusion Welds)
- c) Flattening Test (Electric Resistance Welds)

PLN 5.6.2 Sampling for Destructive Tests

The following samples shall be selected for destructive testing:

a) First Sample

A section long enough to provide all the test specimens and material shall be cut from the selected pipe.

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b) **Second Sample**

If the test specimens and material from the first selected pipe fail to pass any of the tests, a section long enough to provide the appropriate specimens for the tests failed by the first sample shall be cut from two further pipes.

c) **Third Sample**

If the test specimen from the second sample fails to pass the test(s) a similar section shall be cut from each of a further ten pipes.

d) **Compliance**

The piping shall be considered as complying with the specification if after testing of the first or the second or the third sample no defect is found.

PLN 6 FLANGES

- a) Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the drawings. Flanges not covered by BS EN 1092 shall be manufactured according to NWS 1676 Revision 0 dated May 1981. Unless otherwise indicated on the drawings or specified in the Bill of Quantities, flanges shall be of forged Grade 300WA steel or ASTM A105.
- b) Sealing faces shall be machined flat to a tool-mark of 0.8 mm to 1.25 mm pitch spiral or concentric serrations and back of flanges to be either machined or spot-faced around holes with sufficient clearance to ensure proper seating of bolt heads and nuts. All bolt holes shall be drilled perpendicular to the flange face. Bolt holes shall be positioned off-centre and symmetrically off-set from the vertical centre lines of the flange and flanges shall be installed truly square to the axis of the pipe. The Contractor shall check the compatibility of drilling of all flanges to be connected together.
- c) Flange thicknesses and bolt sizes shall conform to the appropriate table of BS EN 1092 or NWS 1676 Revision 0 dated May 1981 for flanges not covered by BS EN 1092. The Contractor shall satisfy himself that the flanges in his supply shall match the flanges supplied by others or at interfaces between Subcontractors, if any.
- d) The Contractor shall ensure that the drilling patterns of pipe specials to be installed on both sides of valves and flow meters will match that of the appropriate supplied valve and flow meter.
- e) All flanges designed for pressure ratings up to and including 1600 kPa, shall be flat faced with full face gaskets. Flanges designed for pressure rating exceeding 1600 kPa shall be raised face flanges supplied with ring gaskets. Flanges with pressure ratings of 6400 kPa and higher and flange sizes of 2500 mm diameter and larger, irrespective of pressure

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- rating, shall incorporate an “O” ring groove. Details of the “O” ring groove shall be furnished by the Contractor for consideration by the Engineer.
- f) All gaskets supplied under this Contract shall be of tanged graphite full face for flat joint faces and aramid and glass fibre with nitrile rubber binder to BS 7531 ring face for raised faces. Gaskets shall be suitable for the specified pressures with a minimum thickness of 3 mm and purpose made to the dimensions of the matching flanges. Joints in gaskets shall be kept to the minimum. Where not avoidable, joints shall be a tight fitting dovetail design.
 - g) Corrosion protection for the area not clamped shall be similar in all respects to that applied externally to the pipework/valve/pump.
 - h) All mill scale on flanges shall be removed by abrasive blasting before flanges are fitted and welded to pipes and fittings.
 - i) All flanges shall be supplied complete with bolts, nuts, washers and gaskets. Rubber joint rings shall comply with SANS 4633.
 - j) Puddle flanges shall not be drilled.
 - k) Some flexible couplings to be restrained by means of a restraining flange. Unless specified on the Drawings, the diameter, number and length of the long restraining bolts as well as any possible pipe wall thickening shall be designed by the Contractor with the assistance with the manufacturer. The effect of cyclic loading and fatigue must also be taken into consideration. The seal retaining flange on the flexible coupling may be factory machine scalloped to accommodate the long bolts. All the necessary nuts, washers, etc. for the restraining bolts must be provided by the Contractor.

Restraining flanges need not have all the bolt holes specified in the applicable flange drilling table. Only those required for the long restraining bolts need to be provided. These holes must comply with the applicable flange drilling table and be spaced equally on the flange PCD and symmetrically around the flange centre lines.

- Restraining bolts to be positioned so as to not interfere with any stubs specified for an item.
- l) Blank (Blind) flanges for pipes equal to or greater than 400 dia to be provided with two suitable lifting handles with coating similar to the blank flange.

PLN 7 FLEXIBLE COUPLINGS AND FLANGE ADAPTORS

Flexible couplings and flange adaptors shall be the Viking Johnson or Klamflex type or similar approved by the Engineer. Straub, Arpol or similar clamp on couplings are not acceptable.

Manufacturer of straight and stepped couplings (SR-C & ST-C) as well as flange adaptors (FA) to be approved by the Engineer. Couplings must be able to withstand hydrostatic test pressures of 1.5 times the specified design pressures and coupling flanges must be designed to withstand all stresses due to tightening of the bolts.

Rubber rings shall generally comply with SABS 974 Class F.

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Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

Coupling installation gaps to comply with supplier's specification.

Applicable to all flange adaptors:

- Studs may not be welded onto flange.
- Flange to be drilled and tapped for threaded studs where applicable.
- Drilling to suit connecting flange.

PLN 8 BOLTS, THREADED RODS, STUDS, NUTS AND WASHERS

The following specification is applicable:

- (a) The threads of all bolts, nuts and studs shall be in accordance with SANS 1700-7-3, 1700-7-5, 1700-14-3, 1700-14-4 (in part);
- (b) No brass bolt or stud shall have a diameter of less than 6mm;
- (c) Two washers shall be installed underneath each bolt and nut;
- (d) Each bolt shall protrude by at least three threads but not more than five threads through the nut with all washers in position and all bolts at a flange must be of equal length;
- (e) The Contractor shall supply to the Employer any special tool required for any nut, bolt, screw or other fastener used in a position which is not accessible using conventional tools. This also applies where the size or shape of the fastener is not conventional.
- (f) Bolts, threaded rods, studs, nuts and washers shall be hot dipped galvanised to SANS 763 or ISO 1461 and shall be coated with molybdenum disulphide lubricant after installation.
- (g) Bolts, shall comply with SANS 1700 Grade 8.8.
- (h) Stainless steel threads shall be treated with nickel base anti-seize corrosion protection compound.

PLN 9 THERMIT WELDING PADS

Where pipes and specials are to be jointed by means of flexible couplings and will be subjected to cathodic protection, the manufacturer shall weld steel plates not less than 50 x 75 x 10 mm thick 250 mm from each end of all pipes during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for thermit welding pad bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

PLN 10 MARKING OF PIPES

All pipes and specials shall be clearly hand stamped alongside a longitudinal or spiral weld on one end of the pipe with the following.

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- a) Grade and thickness of steel
- b) Serial number of the pipe or specials
- c) Outside diameter
- d) Factory hydraulic test pressure in kPa

PLN 11 UV PROTECTION OF COATINGS

All pipes with MDPE, 3LPE or Bituguard coatings shall be painted with a white polypropylene overcoat [to be approved by the Engineer] for protection against UV. The overcoat to be maintained by applying additional layers until the pipe is backfilled.

PLN 12 HANDLING, DELIVERY AND STORING OF PIPES AND SPECIALS

The contractor shall ensure that pipes and specials including coating and lining are not damaged.

Coated pipes and fittings shall be handled with the use of padded slings of width sufficient to prevent damage to the coating. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets and any other equipment with a possibility to damage the coating shall not be used. Slings shall be suitably rated for the loads to be handled and in good condition. Deteriorated slings shall not be used.

All pipes are to be handled with the aid of a “spreader” lifting beam. The dragging or skidding of pipes and specials in contact with the ground shall not be permitted.

Pipes shall be stacked with a minimum clearance of 100 mm between adjacent pipe walls and a minimum of 200mm clear of the ground. Pipes shall be stored on sand bags with sufficient supports to prevent permanent longitudinal deflections. Sandbags are required at least at one third of a single pipe length from each pipe end. The sand bags shall be at least 500 mm wide for pipes with Bituguard coating.

Pipes shall also be stacked in a manner that limits loading on lower layers of pipes. Any pipe showing permanent ovality as a result of surcharge loading will be rejected.

All pipe deliveries shall be accompanied by delivery notes which will be checked by the Engineer on-site. The Engineer reserves the right to not accept and reject pipe deliveries where there are discrepancies.

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PLQ: CORROSION PROTECTION OF STEEL PIPES AND FITTINGS

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PLQ 1 SCOPE

This specification covers various corrosion protection systems for cast iron, steel and stainless steel pipes and fittings for the conveyance of water at ambient temperatures.

PLQ 2 CORROSION PROTECTION SYSTEMS

PLQ 2.1 Standards and codes

The following standards and codes form part of this specification. Unless otherwise specified herein, the latest edition shall apply.

ASTM–American Society for Testing and Materials

ASTM D2240	Standard test method for rubber property (Durometer Hardness)
ASTM D4541	Standard test method for pull-off strength of coatings using portable adhesion testers
ASTM G14	Standard test method for impact resistance of pipeline coatings (falling weight test)
ASTM D4285	Standard test method for indicating oil or water in compressed air
ASTM G62	Standard test methods for holiday detection in pipeline coatings

BS EN–British Standard European Norm

BS EN 10289	Steel tubes and fittings for onshore and offshore pipelines. External liquid applied epoxy and epoxy-modified coatings
BS EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings
BS EN 12068	Cathodic protection - External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection - Tapes and shrinkable materials
BS EN 13000	Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating

ISO–International Organization for Standardization

ISO 1514	Paints and varnishes – Standard panels for testing
ISO 2808	Paints and varnishes – Determination of film thickness
ISO 4624	Paints and varnishes – Pull off test for adhesion

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ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8502	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness
ISO 8503	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces. Part 2: Method of grading of surface profile of abrasive blast-cleaned steel-comparator procedure. Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - stylus instrument procedure. Part 5: Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of steel substrates before application of paints and related products - Surface preparation methods - part 2: Abrasive blast cleaning
ISO 11124-1	Preparation of steel substrates before application of paints and related products - Specifications for metallic blast cleaning abrasives - Part 1: General introduction and classification Part 2: Chilled iron grit Part 3: High-carbon cast-steel shot and grit Part 4: Low-carbon cast-steel shot
ISO 12944-4: 2017	Paints and varnishes — Corrosion protection of steel structures by protective paint systems - part 4: Types of surface and surface preparation
ISO 12944-5: 2018	Paints and varnishes — Corrosion protection of steel structures by protective paint systems - part 5: Protective paint systems

NACE - National Association of Corrosion Engineers

NACE RP0274	High-Voltage electrical inspection of pipeline coatings prior to installation
NACE RP0287	Field measurement of surface profile of abrasive blast cleaned steel surfaces using a replica tape
NACE SP0394	Application, performance, and quality control of. plant-applied, fusion-bonded epoxy external pipe

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SSPC–Steel Structures Painting Council

SSPC PA 2	Measurement of dry coating thickness with magnetic gauges (Steel Structures Painting Manual, Ch 5 - Paint Application Specs.)
SSPC SP1	Solvent cleaning
SSPC SP11	Power tool cleaning to bare metal
SSPC SP 15	Commercial Power Tool Cleaning.
SSPC SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

South African Bureau of Standards

SANS 241	Specifications for drinking water
SANS 1160:2011	Drinking water system components - Health effects
SANS 1217	Internal and external organic coating protection for buried steel pipelines

PLQ 2.2 Standard corrosion protection systems

The following corrosion protection systems shall apply unless otherwise specified in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

PLQ 2.2.1 Buried steel pipework

All specials, fittings and couplings shall be lined and coated with epoxy paint. After installation the specials, fittings and couplings shall be protected with a tape wrapping system in accordance with ISO 21809-3:2016/A1:2020. The following alternative systems are applicable:

- Type 10 – hot applied bituminous tapes, minimum 5mm thickness (e.g. Densotherm HD).
- Type 11A – Petrolatum tapes, with mastic filler and external bond breaker (e.g. Denso Petrolatum).
- Type 12A – Polymeric tapes, with pressure sensitive adhesive, minimum thickness 300µm (e.g. Denso MDP 032).
- Type 12A – Polymeric tapes, with polymer modified bitumen mastic adhesive, minimum thickness 1000µm (e.g. Denso Ultraflex or CPT).
- Type 13A – Reinforced viscoelastic tape with integral or applied polymeric outer wrap, minimum thickness 1300µm (e.g. Stopaq Wrappingband CZH)

The type, combination and application of the tape wrapping system shall be as detailed in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

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Standard pipe lengths shall be lined with epoxy paint and coated with fusion bonded medium density polyethylene (FBMDPE), Polymer Modified Bitumen, 3LPE or Rigid Polyurethane as specified below in this specification, unless otherwise specified in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

Where the application of epoxy lining and the testing thereof is not feasible for a specific pipe or special or fitting of small diameter, the Contractor shall notify the Engineer and request the approval of the Engineer for hot-dipped galvanized lining and coating of the particular pipe or special or fitting as specified below in this specification.

PLQ 2.2.2 Pipework inside chambers

a) New pipework:

Fittings, specials and couplings shall be coated and lined with epoxy paint.

Where the application of epoxy lining and the testing thereof is not feasible for a specific pipe or special or fitting of small diameter, the Contractor shall notify the Engineer and request the approval of the Engineer for hot-dipped galvanized lining and coating of the particular pipe or special or fitting as specified below in this specification.

The outside end of the fitting cast into the wall as well as flanges and couplings outside the chamber shall be protected with a Denso Clingwrap protection system.

After installation and where specified in project specific specifications/employer's requirements or in the bill of quantities or on the drawings, the pipe shall be painted with re-coatable polyurethane to the Employer's colour coding specification. All systems to comply with ISO 12944-4 and 12944-5 (Table C.4 System C4.07).

b) Deteriorated aged external coatings shall be repaired as follows:

i) General

The area to be repaired shall be demarcated to the extremity of sound coating which shall retain a firm edge during surface preparation. If the apparently sound coating does not display a firm edge during surface preparation, the repair shall be extended until a firm edge is obtained.

The sound coating adjacent to the repair area shall be feathered and roughened using abrasive paper only for a distance of 50mm from the edge of the exposed steel.

Surface preparation shall be undertaken by means of one of the following techniques:

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- Abrasive blast cleaning of steel surface to Sa 2 ½ of ISO 8501-1 using portable vacuum recovery blasting equipment.
- Mechanical cleaning of steel surface using Bristle Blaster™, abrasive flapper disc or power sander to SSPC SP15. Grinding discs may not be used.

The prepared steel surface shall be free of moisture, dust & debris prior to application of the repair coating.

Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.

Total soluble salts shall be in accordance with the requirements of the specific coating supplier when tested in accordance with SANS 8502-6 (Bresle Patch).

The feathered edge of the sound epoxy shall be activated using MEK or the solvent compatible with the repair coating.

ii) Aged epoxy coated pipework

The repair material shall be aluminium flake pigmented surface tolerant epoxy mastic (e.g. Carbomastic 15) or similar approved by the Engineer plus re-coatable polyurethane to the Employer's colour coding specification.

The repair coating shall be applied in multiple coats to match the dry film thickness of the original coating. (minimum 300 micron).

The painted area shall be tested for pinholes and thickness.

iii) Aged bitumen coated pipework

The repair material shall be Polymer Modified Bitumen heat applied wrapping (Densotherm HD) or similar approved by the Engineer.

PLQ 2.2.3 Pipework exposed to sunlight

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for coating application as per ISO 12944-4.

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Atmospheric exposure (Inland) ISO 12944-5: 2018 Table D.1 System G3.02:

Galvanised pipes shall be coated in the factory with epoxy primer (80 micron).

Erection damage must be repaired with “single pack zinc rich epoxy primer” followed by a full coat of silver polyurethane acrylic (50 micron)

Atmospheric Exposure (Coastal) ISO 12944-5:2018 Table D.1 System G5.05:

Galvanised pipes shall be coated in the factory with epoxy primer (80 micron) plus epoxy intermediate (125 micron per coat).

Erection damage must be repaired with “single pack zinc rich epoxy primer” and epoxy intermediate, followed by a full coat of silver polyurethane acrylic (50 micron)

After installation the pipe shall be painted with re-coatable silver polyurethane acrylic (50 micron) as per ISO 12944-5

- b) Pipe diameter larger than 150mm

Pipework shall be lined with epoxy paint.

Atmospheric exposure (Inland) ISO 12944-5: 2018 Table C.3 System C3.06:

Pipes shall be coated in the factory with two component inorganic zinc silicate primer (75 micron) plus one coat of silver polyurethane acrylic (50 micron).

A second coat of silver polyurethane acrylic (50 micron) must be applied on site. The inorganic zinc silicate must be repaired with “single pack zinc rich epoxy primer”.

Atmospheric Exposure (Coastal) ISO 12944-5:2018 Table C.5 System C5.08:

Pipes shall be coated in the factory with two component inorganic zinc silicate primer (75 micron) plus two coats of epoxy intermediate (125 micron per coat).

Erection damage must be repaired with “single pack zinc rich epoxy primer” and epoxy intermediate, followed by a full coat of silver polyurethane acrylic (50 micron)

PLQ 2.2.4 Exposed pipework inside buildings

- a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable polyurethane site application.

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After installation the pipe shall be painted with re-coatable polyurethane to the Employers colour coding specification. All systems to comply with ISO 12944-4 and 12944-5:2018 (Table D.1 System G2.01)

- b) Pipe with diameter larger than 150mm

Pipes, fittings and couplings shall be lined and coated with epoxy paints.

After installation the pipework external shall be painted with re-coatable polyurethane to the Employers colour coding specification. All systems to comply with ISO 12944-4 and 12944-5:2018 (Table C.2 System C2.05).

PLQ 2.2.5 Pipework inside water retaining structures

All pipework (including stainless steel) inside water retaining structures and cast into the walls or floor of water retaining structures shall be lined and coated with epoxy paint.

All stainless steel shall be grade 316L.

PLQ 3 SURFACE PREPARATION

Contractors must submit information on the cleaning methods to be used to comply with the specified requirements.

PLQ 3.1 Surface preparation of steel surfaces

All projections, sharp edges, layers that have formed and tool marks must be removed from the surface so that the surface is smooth, and it must be abrasive blast cleaned in accordance with section 5.3 of SANS 10064:2011 so that it meets the following requirements:

- (a) A grade of cleanliness of Sa 3 of ISO 8501-1 for immersion/buried conditions or Sa 2 ½ of ISO 8501-1 for atmospheric exposure.
- (b) A surface profile between 60 micron and 85 micron when tested in accordance with SANS 5772.
- (c) Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.
- (d) The profile produced shall be angular and shall be in accordance with the requirements of the material product data sheet when tested in accordance with SANS 5772 (profile gauge) or SANS 8503-5 (replica tape)
- (e) Water soluble salts shall not exceed 100mg/m² when tested in accordance with the Weber Reilly Method or conductivity measurement. Lower values may be required for immersion applications.
- (f) Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the requirements above.

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PLQ 3.2 Surface preparation of galvanized surfaces

Surfaces to be coated shall not be passivated.

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SANS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with SSPC SP16. Cracking, flaking or any form of de-lamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

Finally, all dust and debris shall be removed by vacuum-cleaning.

Epoxy primer for galvanised surfaces shall be applied immediately after surface preparation to a minimum dry thickness of 50 µm.

PLQ 3.3 Surface preparation of stainless steel surfaces

Oil and grease contamination shall be removed by:

- Steam-cleaning
- An emulsifiable or aqueous detergent, or
- An alkaline cleaning solution.

Stainless steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive. The use of steel shot and steel or cast iron grit is strictly prohibited.

The grade of cleanliness shall be in accordance with SSPC SP16.

Surface profile shall be in the range of 30 to 50 µm.

Where blasting is impractical, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment must be used.

Dust and debris shall be removed by vacuum-cleaning.

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PLQ 4 HOT-DIP GALVANIZING

The following specification is applicable:

- (a) Where galvanising is specified or a requirement of the design, such galvanising shall be performed by the hot-dip process to SANS EN 10240 in part and SANS ISO 1461;
- (b) For all parts, other than wires, the equivalent zinc coating thickness shall not be less than 455 g of zinc per square metre of surface;
- (c) The galvanising must be clean, smooth, of uniform thickness, unblemished and free from defects;
- (d) All drilling, welding, cutting, sawing, punching, filing and bending shall be complete and the metal shall be cleaned of any machining blemishes, millscale, rust and lubricants, before galvanising;
- (e) Galvanised areas must be kept free of lubricants. Surfaces which are in contact with oil shall not be galvanised or cadmium plated;
- (f) Electrolytic deposition of zinc is not acceptable.
- (g) Unless otherwise specified, steel pipes up to 150 mm dia shall be hot-dipped galvanized. Hot-dip galvanizing to be in accordance with SANS 121 ISO 1461 except that minimum thickness shall be 55 micron. Cut ends and small damaged areas shall be repaired by the application of a zinc-rich epoxy (single pack) to SANS 121 ISO 1461 (ZINC GALV 1 – Dulux or POLY GALV – Plascon).
- (h) Only heavy duty galvanising shall be accepted and all items to be provided with a SANS approval certificate.

PLQ 5 EPOXY PAINTS

PLQ 5.1 General

Epoxy paint shall comply with SANS 1217 or ISO 12944-4 and ISO 12944-5. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals for internal linings/immersion conditions, or Sa 2½ of ISO 8501-1 or SSPC SP16 for non-ferrous metals for atmospheric exposure.

The following will be applicable where epoxy paint is specified:

- Lining of pipes with nominal diameter equal or larger than 600 mm and standard pipe lengths of 9,144 m, 12,192 m, 18,3 m and 19.2 m:

Solvent free epoxy SANS 241 certified (Pipecoat SFX or similar product approved by Engineer), with a minimum dry film thickness of 500 micron and a maximum dry film thickness of 800 micron. (Equivalent to ISO 12944-5:2018, Table C.6 System I.06)

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- Lining and coating of all other pipes, specials and fittings, except where multi-purpose epoxy coating is specified:

Solvent borne epoxy (Carboguard 891 or similar product approved by Engineer) with a minimum dry film thickness of 500 micron and a maximum dry film thickness of 800 micron. (Equivalent to ISO 12944-5:2018, Table C.6 System I.06)

Epoxy paint and the repair kit for the repair of epoxy shall be from the same manufacturer.

Edges with epoxy paint shall have a radius of 3 mm or 50 % of the pipe wall thickness (smaller of two).

Where another type of coating is specified, epoxy paint lining shall continue around pipe edge for each of the following:

- Flanged end*

Onto both flange faces, extending for 50 mm (min) onto pipe outer wall beyond flange.

- Ends suitable for straight or stepped couplings or flange adapters*

Onto pipe outer wall for 250 mm (min) from pipe end.

- Ends suitable for flange adapters, incorporating a restraining flange*

Onto pipe outer wall from pipe end, up to and including both faces of the restraining flange as well as 50 mm (min) beyond the restraining flange.

The following specification shall be applicable to pipes, specials and fittings to be welded on site:

- In the factory:

Abrasive blast cleaning of complete steel surface to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals. Apply epoxy paint to 100mm from pipe end.

- On site:

Abrasive blast cleaning of steel surface to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and 50 mm of painted surface to a surface profile of 60 – 85 microns.

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Apply epoxy repair kit from the same manufacturer as the factory applied epoxy to a minimum dry film thickness of 500 micron. The type of epoxy repair kit shall be subject to the approval of the Engineer.

At completion of the laying of pipes, after the epoxy lining of welded joints, repair of lining defects and cleaning of pipes and before filling of the pipe with water, the Contractor shall be responsible for the holiday (pinhole) testing of the epoxy lining of the complete pipeline. The Contractor shall implement measures to prevent entrance by persons, animals, water or any other foreign matter into the sections where holiday testing was successfully completed.

Holiday testing shall be undertaken in accordance with ASTM D5162 Test method B: High Voltage Spark Testing.

PLQ 5.2 Repair/rehabilitation of aged internal epoxy linings on site

The following deviations from paragraph PLQ 5.1 shall be applicable to the repair/rehabilitation of aged internal epoxy linings of steel pipes, specials and fittings on site:

The repair material shall be a surface tolerant reinforced epoxy with minimum 90% volume solids. A certain level of solvent is preferred in order to enhance the wettability, flow and adhesion characteristics of the material. The following materials are approved for this application:

- Carboguard 891GF Glass Flake System from Stoncor
- Ceramic Epoxy from Spec Coats
- Zip E from Corrocoat

Glass flake pigmented epoxy coatings from other manufacturers may be considered subject to approval by the Engineer.

Alternative products (e.g. Pipecoat SFX or Carboguard 550) may be considered for special cases of large scale repair work under controlled climatic conditions and with special measures for quality assurance in place and subject to approval by the Engineer. These alternative products shall be subjected to site application trials.

The area to be repaired shall be demarcated to the extremity of the sound epoxy coating which shall retain a firm edge during surface preparation. If the apparently sound epoxy does not display a firm edge during surface preparation, the repair shall be extended until a firm edge is obtained.

The sound epoxy adjacent to the repair area shall be feathered and roughened using abrasive paper only for a distance of 50mm from the edge of the exposed steel.

Surface preparation shall be undertaken by means of one of the following techniques:

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- Abrasive blast cleaning of steel surface to Sa 2½ of ISO 8501-1 using portable vacuum recovery blasting equipment.
- Mechanical cleaning of steel surface using Bristle Blaster™, abrasive flapper disc or power sander to SSPC SP15. Grinding discs shall **not** be used.

The prepared steel surface shall be free of moisture, dust & debris prior to application of the repair coating.

Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.
Total soluble salts shall be in accordance with the requirements of the specific coating supplier when tested in accordance with SANS 8502-6 (Bresle Patch).

The feathered edge of the sound epoxy shall be activated using MEK (Carboline Surface Prep 1 or similar approved by the Engineer) or the solvent compatible with the repair coating.

The epoxy repair coating shall be applied by brush ensuring the paint is worked into the surface of both the exposed steel and the feathered edge of the sound epoxy, overlapping 50mm onto the sound coating.

The repair coating shall be applied in a single coat to a minimum dry film thickness of 600 micron.

The painted area shall be tested for pinholes and thickness.

PLQ 6 UV-RESISTANT MULTI-PURPOSE EPOXY PAINT

Multi-purpose Epoxy shall be surface tolerant, self-priming aluminium pigmented epoxy mastic.

PLQ 7 RE-COATABLE POLYURETHANE

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The surface shall be vacuum cleaned to remove dust and debris.

Over-coat with a 40 µm minimum layer of re-coatable polyurethane in accordance with the Employer's colour code.

PLQ 8 FUSION BONDED, MEDIUM DENSITY, POLYETHYLENE COATINGS (FBMDPE)

A uniform FBMDPE coating must be obtained by dipping the already prepared and heated pipe into a fluidified bed of FBMDPE powder which then fuses directly on to the heated surface.

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The pipe coating shall be Sintakote II complying with all aspects of AS 1193, AS 4131 and AS 4321 of the latest revisions.

All coating materials shall be supplied complete with an original ISO 17050-1 Certificates of Conformity (COC) for the materials, clearly indicating compliance with all mechanical, physical and chemical properties of the coating, as defined in AS 4321, AS 1193 and AS 4131.

The supplier shall ensure that testing takes place as per AS 4321 Appendix A, as defined in Table A1 for the pipeline coating at the mill. In addition to this, a detailed third party report indicating compliance as per the 5 Yearly Type Testing and the annual testing as per Table A1 shall be submitted to the Engineer before production commences.

The minimum Dry Film Thickness (DFT) shall be 2.3mm minimum or as per Table 1 of AS 4321 for the different pipeline diameters as agreed by the Engineer.

The pipeline frequency of testing during production shall be as per AS 4321 Table 2.

The surface profile shall be angular and at least 60 μ -75 μ and the dust and debris level shall never exceed Class 2 ISO 8502-3 during production, the latter shall be confirmed during production on every 5th pipe and records shall form part of the hand-over pack issued to the Engineer. The cutback distance of the coating shall be 75mm from the pipe end.

PLQ 9 POLYMER MODIFIED BITUMEN (BITUGUARD)

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen. It is also applicable to modification, refurbishment and repairs on pipes coated with standard (oxidised or blown) bitumen fiberglass coatings.

PLQ 9.1 Applicable Standards

This part of the Specification makes reference to the standards listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

British Standards

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints: Part A 6 (replaced by EN 535) – Determination of flow time of paints. Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.

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BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.
BS EN 10300	Steel tubes and fittings for onshore and offshore pipelines – Bituminous hot applied materials for external coating.

Swedish Standard

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.
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American Standard

ASTM D 113-86	Ductility of bituminous materials.
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

PLQ 9.2 Materials

PLQ 9.2.1 Primer

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen. The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in the table below. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in the table for not less than 6 months from the date of delivery.

CHARACTERISTICS OF PRIMER

CHARACTERISTIC	REQUIREMENTS	METHOD OF TEST
Viscosity at 23°C	35-60 seconds	Flow cup No 4
Volatile matter (max. % loss by mass)	75	BS3900: Part A6 = EN 535 BS3900: Part B2 = ISO/DR 1515 (105°C for 3 hours)

PLQ 9.2.2 Polymer Modified Bitumen

a) Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

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- b) Filler Grading
Method of test to BS 1796 modified to use the metric sieves specified in BS 410.
Passing 90 microns – not less than 93%.
Passing 250 microns – not less than 99%.
- c) Characteristics of the Polymer Modified Bitumen
The material shall conform to the requirements given in the table below when tested in accordance with the methods specified.
- d) Performance Tests of the Polymer Modified Bitumen System
The polymer modified bitumen shall be of thermoplastic rubber/bitumen modification.

The polymer modified bitumen containing mineral filler shall pass the performance test specified in the following table:

CHARACTERISTICS AND PERFORMANCE TEST: PMB

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Softening Point	ASTM D36	°C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm ³	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm ²	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

Notes:

The test plates shall be cleaned by abrasive blasting to grade Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m².

- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbonded shall not exceed the

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permitted value shown in the table.

- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

PLQ 9.2.3 Outerwrap

- The outer wrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outer wrap to provide maximum protection.
- The outer wrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in the table below.
- The characteristics of the outer wrap shall comply with the requirements of the table below and shall be determined in accordance with the test procedure.

CHARACTERISTICS OF OUTER WRAP SATURANT

CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

PHYSICAL CHARACTERISTICS OF OUTER WRAP

CHARACTERISTIC	TYPE A	TYPE B	METHOD OF TEST
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m ²	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

PLQ 9.3 Application

PLQ 9.3.1 Care of Wrapping Materials

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

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PLQ 9.3.2 Care of Pipe

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

PLQ 9.3.3 Marking

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

PLQ 9.3.4 Blast Cleaning

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and surface profile amplitude 75 µm. Refer to 37.15 for detailed description of surface preparation process.

PLQ 9.3.5 Priming

- a) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.
- b) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.
- c) The primer should be applied at a pipe temperature of 10°C (or above) or 3°C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.
- d) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

PLQ 9.3.6 External Coating and Wrapping Application

- a) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and

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thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outer wrap.

- b) All primed surfaces shall be clean and dust free immediately prior to coating.
- c) The coating (including the outer wrap) shall have a minimum average thickness as specified in SANS ISO 2808 (5.5 mm minimum average and 5 mm minimum at any point) The coating shall be reinforced by a spirally-wound layer of outer wrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outer wrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.
- d) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.
- e) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of ± 5 mm, unless otherwise specified by the Employer or his representative.
- f) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

PLQ 9.4 Inspection and Testing

The Contractor shall be responsible for and shall bear the cost of a system of inspection and repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

- g) Monitoring of grit size and the finish of blast cleaned pipe.
- h) Viscosity measurement and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.
- i) Adequate temperature control of the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in the table below.
- j) Visual checks on the outer wrap and the appearance of the final wrap.
- k) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.

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- l) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.
- m) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m² of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a signification number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

'IN PLANT TESTING'

TEST	FREQUENCY OF TESTING
1. Softening Point	Twice per working shift
2. Penetration at 25°C	Twice per working shift
3. Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Authority (AIA), who would be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.

When tested, the wrapping shall not be disbonded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

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The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

PLQ 9.5 Methods of Testing

PLQ 9.5.1 Testing of Wrap Characteristics

a) General
The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

b) Thickness
The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m² and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

c) Weight per m²
The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of $\pm 2\%$.

d) Tensile Strength
The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width.

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested

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and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

PLQ 9.5.2 Bond Test for Coated Pipes

- a) Measure the temperature of the coating with a surface thermometer.
- b) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.
- c) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.
- d) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.
- e) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.
- f) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

PLQ 9.6 Handling

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

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PLQ 9.7 Repairs

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

PLQ 10 THREE LAYER POLYETHYLENE COATING (3LPE)

The 3LPE coating shall comply with ISO 21809-1. The Canadian Specification CSA Z245.20/Z245.21 is not applicable.

The materials supplied as part of the 3LPE coating, including the Fusion Bonded Epoxy (FBE), Copolymer adhesive and Polyethylene (PE) outer coating shall be supplied with ISO 10474 or EN 10204 Inspection Certificates 2.1 and 2.2, giving the results of the testing of coated pipes, as supplied on the contract/purchase order and signed by an authorised representative of the Engineer.

An Inspection and Testing Plan (ITP) providing an overview of the sequence of inspections and tests, including appropriate resources and procedures and a Quality Control Procedure (QCP) shall be submitted for the approval of the Engineer's representative prior to coating production commencing.

Subsequent to the approval of the documentation detailed above, a Procedure Qualification Trial (PQT) shall take place and shall be witnessed by the Engineer's representative as well as subsequent inspection/testing of its properties, to confirm that the Application Procedure Specification (APS) is adequate to produce a coating with the specified properties. All to be carried out prior to the start of production.

The 3LPE shall be Type B coating, as per ISO 21809-1 Table 1.

The minimum thickness of the 3LPE coating shall be as follows:

FBE	0.30 mm
Adhesive	0.20 mm

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HDPE 2.00 mm for nominal pipe diameter up to and including 250 mm
 2.50 mm for nominal pipe diameter larger than 250 mm but less than 600 mm
 3.0 mm for nominal pipe diameter 600 mm and larger

The 3LPE shall have minimum total thickness as above, and on heavier wall pipes it shall comply with class B3, as per ISO 21809-1 Table 2.

Polyethylene layer cut back shall be provided at pipe ends as follows:

Pipe ends shall be supplied as bare steel, free of all coating, for a distance of 100 mm (+25mm/-0mm tolerance) from the pipe end. In addition, each pipe end shall be left without polyethylene / adhesive coating so that a 20 mm (+10mm/-0mm tolerance) FBE toe protrudes on the steel beyond the cutback polyethylene coating layer.

The ends of the coating shall be bevelled at 30° to 45°.

The applicator shall use epoxy material that is in accordance with Table 3, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall use adhesive material that is in accordance with Table 4, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall use PE/PP material that is in accordance with Table 5, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall provide batch certificates supplied by the manufacturer of each material and shall contain the information given in Table 6 ISO 21809-1. The batch certificate shall state test methods and acceptance criteria. The applicator shall identify the materials and shall confirm that the certificates comply and relate to the specified materials, as well as the requirements stipulated in Clauses 8.3.2 and 8.3.3 ISO 21809-1.

Prior to the start of coating production and any specified PQT, the applicator shall prepare an APS as per Clause 9.2 ISO 21809-1.

The APS, including any Engineer approved written revisions, shall be approved by the Engineer prior to the start of production and any specified PQT and there shall comply with the requirements of Table 7, Class B coating system.

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The APS shall be verified by a PQT in accordance with ISO 21809-1 Annexure L. The applicator shall prepare an ITP and a daily log to record quality control data in accordance with Annexure L of ISO 21809-1.

Prior to the commencement of the surface preparation for the coating operations, a visual inspection shall be performed on the bare steel pipes in order to verify that there are no steel or weld defects (welding slag, spatter or raised/sharp edges) or contamination with oil, grease, soil, dirt and similar contaminants.

In the event that steel defects are detected they shall be rectified using a file, light grinding or any other suitable tool as stipulated in API 1104 Clause 13.10. This intervention shall not reduce the pipe wall thickness below the tolerances specified in the relevant Specifications. In case the steel defect is of the nature that simple correction of this defect cannot be performed, the pipe affected by this defect shall be quarantined until the appropriate measures are taken.

In case oil, grease, or any other residues (e.g. adhesive materials or similar contaminants) are present, then they shall be removed using a high pressure water based detergent cleaner, and/or a suitable “solvent” as per the requirements of SSPC-SP-1 Specification. In the event of other “adherent” contaminant being present, then power tool brushes or any other appropriate method may be utilised in order to remove the contaminant from the pipe surface prior to grit blasting.

The blast cleaning abrasives shall be, at all times, kept dry, clean and free from contamination. The blast cleaning shall be performed when the following conditions are satisfied:

- The steel surface temperature is at least 3°C above the ambient dew point, which shall be checked using a calibrated hygrometer or other method approved by the Engineer.
- The steel surface shall have no traces of moisture;
- The steel surface is protected from bad weather conditions such as rain or strong winds which can bring contaminants such as soil, sand, dirt, salt or any other such similar contaminant.

In the case that the steel surface temperature is less than 3°C above the ambient dew point or traces of moisture are detected on the steel surface, the steel surface shall be heated using induction heating until the steel surface temperature is within the range of 50°C to 60°C. This temperature shall be maintained until all of the moisture has been removed from the steel surface.

Abrasive blast cleaning shall be in strict compliance with ISO 21809-1 Clause 10.1.2 with the exception that the profile shall be measured using ISO 8503-4 (Stylus method), replica tape is not permitted.

As per ISO 8502-3, the cleanliness of the steel surface shall be measured using the ISO Form: “Preparation of Steel Substrates before Application of Paint and Related Products – Test for the

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Assessment of Surface Cleanliness – Part 3: Pressure Sensitive Tape Method.” As prescribed, a strip of clear tension tape shall be placed, tacky side down, onto the blasted steel surface of the pipe after cleaning. The tape shall then be removed from the surface and placed on a piece of white glossy paper where it will be compared to the cleanliness levels provided in the ISO 8502-3 specification procedure. This shall not exceed a “Debris” and “Dust” level of Class/Level 2 at any given time and shall be recorded during pipe production on at least every 5th pipe to confirm compliance and records shall be kept for the client, which may be inspected at any given time.

The salt level on the bare steel pipe surface shall be measured according to ISO 8502-2 and shall be a maximum of 20 mg NaCl/m². The basic procedure of the test shall be to dampen circular piece of test paper of known area with a specified volume of laboratory water containing less than 0.1µg/cm² of salt. The test paper shall then be applied to the pipe for a period of 2 minutes, after which the test paper will be removed from the pipe and its resistivity measured. The salt content on the pipe will then be determined through the calibrated Salt Contamination Meter which uses the negative correlation between resistivity and salt content, along with empirically measured historical data to provide a reading.

If excessive salt contamination is established (≥ 20 mg NaCl/m²) during production testing, then the applicator shall ensure that a “Pre-Wash” system shall be employed prior to coating in order to remove the salt without causing “flash rusting” or any other “surface contamination”. The “pre-wash” shall be performed and shall form an integral part of the production Pre-Qualification Testing (PQT) before acceptance of the “Pre-Wash” procedure.

The maximum time elapsed after completion of the abrasive blasting operation, pre-wash (if applicable) and the application of the P primer shall be 120 minutes if RH < 85% and 60 minutes if RH > 85%. At no time shall the steel surface temperature be allowed to drop below the dew point before application of the P Primer. Should either of these conditions apply, the surface preparation shall be re-inspected and/or the surface preparation repeated as required.

The application of the 3LPE coating shall be in accordance with the approved APS in accordance with Clauses 10.2.2.3 and 4 of ISO 21809-1.

Inspection and testing shall be carried out in accordance with the approved APS and ITP and shall meet the minimum requirements as stipulated in ISO 21809-1 Tables 8 and 9.

Coating repairs shall be addressed in accordance with an Engineer’s approved APS and PQT as per Clause 12 ISO 21809-1.

Pipeline marking shall be as per the Employer’s requirements but shall as a minimum include all aspects detailed in Clause 13 of ISO 21809-1.

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PLQ 11 RIGID POLYURETHANE COATING (RPU)

PLQ 11.1 Introduction

This part of the Specification defines the minimum technical requirements for liquid applied coating for factory coated pipe and specials. The coating system shall comprise a homogenic layer of 100% solids rigid polyurethane mechanically bonded to the metal substrate.

Where specified it shall be used for the external coating of pipes. The pipeline will be buried and will be protected against external corrosion by the external coating and cathodic protection systems. The external coating (primary corrosion protection system) shall be suitable for the operating conditions applying to the specific pipeline.

PLQ 11.2 Standards

Unless otherwise specified herein, the latest edition of the following Standards should be read in conjunction with this Specification:

American Society for Testing and Materials

ASTM D16	Standard Test Method for Paint, related coatings, materials and applications.
ASTM D 543	Standard Test Method for Evaluating the resistance of plastics to chemical reagents.
ASTM D 570	Standard Test Method for Water absorption of plastics.
ASTM D 2240	Standard Test Method for Rubber Property (Durometer Hardness)
ASTM D 4060	Standard Test Method for Abrasion resistance of organic coatings by the Taber abraser.
ASTM D 4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM G14	Standard test method for impact resistance of pipeline coatings (Falling Weight Test)
ASTM D 4285	Method for indicating Oil or Water in Compressed Air

British Standard and European Norm

BS EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings.
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ISO – International Organisation for Standardization

ISO 1514	Paints and varnishes - Standard panels for testing
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 4624	Paints and varnishes - Pull off test for adhesion
ISO 8501-1	Preparation of Steel Substrates Before Application of Paints and

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	Related Products - Visual Assessment of Surface Cleanliness - Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Coatings
ISO 8502	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness
ISO 8503	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces. Part 2: Method of grading of surface profile of abrasive blast-cleaned steel comparator procedure. Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure. Part 5: Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Preparation Methods - Part 2: Abrasive Blast Cleaning
ISO 11124-1	Preparation of Steel Substrates Before Application of Paints and Related Products - Specifications for Metallic Blast Cleaning Abrasives - Part 1: General introduction and classification Part 2: Chilled iron grit Part 3: High-carbon cast-steel shot and grit Part 4: Low-carbon cast-steel shot
NACE – International	
NACE RP0274	High-Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
NACE RP0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape
NACE RP0394	Application, Performance, and Quality Control of Plant-applied, Fusion-Bonded Epoxy External Pipe Coating
SSPC – Society for Protective Coatings	
SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC PA 2	Measurement of Dry Coating Thickness with Magnetic Gauges (Steel Structures Painting Manual, Ch 5 - Paint Application Specs.)
SSPC SP 10	Near-White Metal Blast Cleaning NACE No.2-2000 (Steel Structures Painting Manual, Ch 2 - Surface Preparation Specs.)

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PLQ 11.3 Materials

The required coating shall be a two-component liquid applied rigid polyurethane subject to the approval of the Engineer.

The two components shall have different colours allowing the verification of the correct mixing and checking of the uniformity of the colour of the mixed product.

The coating is considered cured when it has attained the hardness recommended by the product manufacturer.

PLQ 11.3.1 Handling of Materials

Materials shall be handled and stored in accordance with the material manufacturer's recommendations, which shall be available for review by the Engineer at the Contractor's premises. Materials shall be stored in an air-conditioned, temperature-controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected, unless otherwise agreed with the Engineers representative in the factory or on Site.

Materials shall be used in the order in which they are delivered and before their expiry date for use.

PLQ 11.3.2 Documentation from the Materials Manufacturer

The commercial rigid polyurethane coating system offered shall be qualified by the Contractor and will be subject to the Engineer's approval prior to application. Testing should be conducted on each applicable coating and shall meet the acceptance criteria of the table below. The qualification shall be based on tests carried out by an independent recognized certifying body and the relevant documents shall be submitted to the Engineer.

Full traceability of each batch of coating material shall be maintained. As a minimum, the following data shall be compiled and shall be available for immediate review by all parties:

- Name of manufacturer;
- Complete material identification: Trade name, chemical name and type of product details;
- Batch number;
- Date of manufacture;
- Place of manufacture;
- Shelf life / expiry date (if appropriate);
- Health and safety, and environmental instructions;

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- Hazard warnings;
- Storage instructions;
- Quantity; and
- Manufacturing standard.

Any material not labelled with the above information shall not be used.

PLQ 11.3.3 Rigid Polyurethane Properties

The coating material properties and characteristics with respect to the 100% solids rigid polyurethane coating shall comply with the requirements of a Type V coating type in terms of the ASTM D16 Standard. The coating material shall be a homogenic solvent free layer with a chemical three-dimensional covalent cross-linked structure. The layer shall be made up from a liquid two pack coating system with Part A being poly-isocyanate rich and Part B consisting of polyols or amines that ensures relatively short curing times. Aliphatic polyurethanes shall be used above ground and aromatic polyurethanes shall be used below ground.

The performance properties of the coating shall comply with the requirements stated in the following table. The Contractor shall submit a full and comprehensive product datasheet to confirm material compliance with the Specification.

COATING MATERIAL PERFORMANCE PROPERTIES

PROPERTIES	TEST REFERENCE	ACCEPTANCE CRITERIA
Minimum application thickness	BS EN 10290 (Annexure A)	1800 µm (Dry Film Thickness)
Adhesion to steel	ASTM D 4541 Method E	> 15 MPa
Adhesion to factory coating	ASTM D 4541 Method	> 10 MPa
Hardness	ASTM D 2240 (Shore D)	As specified by coating manufacturer
Flexibility	BS EN 10290 (Annexure K)	Pass
Tensile strength	ASTM D 638	>15 MPa at 3mm thickness
Resistance to cathodic disbondment	BS EN 10290 (Annexure E)	r < 8mm (28 days)
Dielectric strength	ASTM D 149	Minimum 15 V/µm
Specific Electrical Insulation Resistance	BS EN 10290 (Annexure F)	10 ⁶ ohm.m ²
Impact resistance	BS EN 10290	> 5J/mm at 23°C >3J/mm at 5°C
Indentation resistance	BS EN 10290 (Annexure H)	<0.2mm at 23°C

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PLQ 11.4 Application

PLQ 11.4.1 Surface Preparation

Refer to Clause PLQ 3 for the general steel surface preparation requirements. The steel surface shall be grit blasted to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals with an anchor profile of minimum 75 µm. The hardness of the abrasive material must be Rockwell C 54 or greater. The abrasive material shall be dry, clean, and free from contamination. Salt contamination tests shall be regularly performed on abrasive to verify that total salt level in the soluble contaminants is less than 25ppm. Extensive grinding shall not be performed without Engineer approval. The anchor pattern shall be restored on all ground surfaces.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for all pipes, specials and joint repairs.

PLQ 11.4.2 Coating Application

The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3°C above the dew point temperature. The work area shall be kept dry as the material reacts with humidity and moisture.

When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

The individual liquid components of the rigid polyurethane coating shall be agitated thoroughly before use to disperse pigments and assure homogeneity. No thinning shall be done and the components shall not be mixed together.

The material shall be applied using a plural component, adjusted to the specified mix ratio on a heated airless spray unit with metering pumps. The width of the spray jet, the set up distance from the substrate surface and the overlap, the pipe rotation speed and the rate of application shall be predetermined for the final required dry film thickness applied in the workshop.

The wet film thickness shall be measured in accordance with ISO 2808. Particular attention shall be paid to the recommended dry film thickness which shall be measured in accordance with SSPC PA 2. No spot measurement may be less than 85% of the specified average thickness. Tools

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and equipment shall be cleaned using only such solvents as are recommended by the product manufacturer. Particular care shall be taken in the handling of the coated items before the coating has reached the minimum value of hardness recommended by the manufacturer. All pipes and other components shall be high spark holiday tested in accordance with NACE RP0274 at the test voltage recommended by the coating manufacturer.

For factory-coated pipe, bends and specials the cut back shall be 150 ± 20 mm. The edge of the cut-back shall be feathered at $30 - 45^\circ$.

PLQ 11.5 Inspection and Testing

The Contractor shall demonstrate that the proposed coating material and procedures will meet the requirements of this Specification when applied to pipes and pipe specials. The Contractor shall provide the documentation proof that the final selected coating material complies with the requirements listed in Table 37/15.

The Contractor shall test the finished coating during production to demonstrate continued compliance with this Specification. Details of all inspections and testing shall be fully documented in accordance with the approved quality control plan mentioned in Clause 37.4.2.

All stages of the surface preparation, coating and testing shall be subject to 100% inspection by the Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection personnel in the factory as well as on Site.

PLQ 11.6 Testing of Production Pipes

The Contractor shall execute the following tests and provide written documentation proof of the test results within the agreed time frames:

PLQ 11.6.1 Visual Inspection (every pipe)

The coating shall be smooth, glossy, and free from pin holes, excessive orange peel effect, bubbling or excessive runs or sags.

PLQ 11.6.2 Dry Film Thickness (every pipe)

DFT shall be inspected in accordance with SANS ISO 2808, with a minimum average thickness of 1.8mm and a minimum of 1.6mm at any point.

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PLQ 11.6.3 Electrical Insulation Defects (Holiday) Inspection (every pipe)

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 15 kV.

PLQ 11.6.4 Hardness Shore ‘D’ (every pipe)

The Shore ‘D’ hardness shall comply with the minimum set by the manufacturer in pre-qualification.

PLQ 11.6.5 Adhesion (1 test per shift)

The pull-off adhesion at 23°C shall be greater than 15 MPa.

PLQ 11.6.6 Cathodic Disbondment (1 test per 50 pipes and commencement of new batch or new production run))

The disbondment shall be less than 8mm radius. BS EN 10290 Annexure E 48hr.

PLQ 11.6.7 Composition (1 test per 50 pipes or new batch or new production run)

The Thermo Gravimetric Analysis (TGA) scan shall be checked against the manufacturer’s qualification scan.

PLQ 11.7 Coating Repairs

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

PLQ 11.7.1 Repairs before Full Cure in the Factory [Within Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

Brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

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PLQ 11.7.2 Repairs after Full Cure [After Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

The coating manufacturer's adhesive primer or activating solvent shall be applied only to the abraded surface.

After the designated curing time, brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

Repairs shall be carried out with repair grade materials from the supplier of the factory applied coating, unless otherwise approved by the Engineer.

The repair material shall be as recommended by the supplier of the factory applied coating. The supplier shall confirm material compatibility and surface preparation requirements. Prior to any repair work, the supplier shall demonstrate the use of the material to the Contractor and Engineer on site.

The repaired area shall comply with the quality control requirements as set out in paragraph PLQ 11.6.

Based on the above the Contractor shall prepare a detailed method statement on the repair of the coating for the approval of the Engineer.

PLQ 12 PETROLATUM TAPE WRAPPING SYSTEM

PLQ 12.1 General

An EN 12068 Class A Petrolatum System shall be used for the wrapping of buried flange and flexible joints and where specified in the Specifications, Bill of Quantities or Drawings. The Denso Clingwrap protection system or similar products approved by the Engineer will also be acceptable.

PLQ 12.2 Surface preparation

Bare pipes and fitting to be prepared to a recommended standard of St2 as specified by the Swedish Standard SIS 05590:

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St2: Hand Tool Cleaning
Removal of all rust scale, mill scale, loose rust and loose paint to the degree specified by hand wire brushing, hand sanding, hand scraping, hand chipping or other hand impact tools or by a combination of these methods. The substrate should have a faint metallic sheen and also be free of oil, grease, dust, soil, salts and other contaminants.

Chamfer any raised edges or steps in the existing coating.

PLQ 12.3 Primer application

Surface to be primed with Priming Solution (e.g. S105 Paste)

Primer is applied to the steel surface with a brush or paint roller. The primer to be thoroughly mixed prior to application.

The primer to cover the entire steel surface, including the nuts and bolts and overlap onto the mill applied primary coating system by a minimum of 200mm.

The primer must not be diluted. Primer cans should remain covered when not in use to avoid solvent evaporation and contamination.

PLQ 12.4 Profiling mastic application

Apply Profiling Mastic to both sides of the fitting to form a generous fillet from the coupling onto the pipe barrel. The Profiling Mastic is also used to cover the bolt heads and nuts to form a regular profile onto which the Petrolatum Tape can be applied.

PLQ 12.5 Petrolatum tape application

Apply one layer of the Petrolatum Tape to the body of the pipe or fitting, ensuring that there is no air entrapped beneath the tape. The Petrolatum must be applied spirally, with a 55% overlap and at least 100 mm onto the factory coating and the barrel of the pipe.

PLQ 12.6 Clingwrap outerwrap tape application

Spirally apply Clingwrap Outerwrap Tape to cover the entire Petrolatum Tape system. Start at one end, wrapping with a 55% overlap, proceed to the other end and ensure the Clingwrap Outerwrap extends 100mm beyond each end of the repair.

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PLQ 13 JOINT COATING SYSTEMS

PLQ 13.1 FBMDPE, three layer polyethylene (3LPE) and Rigid Polyurethane coating

The unprotected area at welded joints shall be protected against corrosion as follows:

- The cutback of the coating shall be 100mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- The factory applied polyethylene pipe surface to which the cold tape wrapping is to be applied shall be abraded with 40 grit abrasive paper or sweep blasted for a minimum of 50 mm onto the mainline coating to obtain a surface profile with an R_z value between 40 and 70 μm
- Abrasive blast clean the steel surface Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals. The surface profile shall be checked in accordance with ISO 8503-1, ISO 8503-4 and ISO 8503-5 with an average R_z larger than 75 μm . All types of abrasive that are used in the preparation of the field joints and small repairs shall comply with ISO 11124-2 to 4.
- The surface to be coated shall at the time of application be dry and free of dust and any contamination detrimental to the adhesion of the coating to the steel substrate. The Contractor shall prepare a detailed method statement on how the field joint area will be kept dry and clean during the application operation. It shall also include the trench space requirements for the application equipment.
- All dust, detritus and salts shall be removed from the metal substrate. The level of salts shall be measured in accordance with the requirements of ISO 8502-9 and shall be $\leq 30 \text{ mg/m}^2$
- The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3°C above the dew point temperature.
- The temperature of the substrate shall be within the application temperature range specified by the coating manufacturer. When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.
- Applicable to 3 LPE only: Apply Denso Protal 7200 liquid epoxy to the blast cleaned surface and adjacent prepared factory FBE coating to a minimum dry film thickness of 400 micron.
- The entire joint surface to be wrapped shall be primed with Denso Butyl Primer P16HT.

Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

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- Apply 100mm or 150mm wide 3 ply PE/Butyl rubber self-amalgamating inner-wrap compliant with DVGW EN12068 Class C 50°C (DENSO S43HT on similar product approved by the Engineer).

The tape shall be applied to ensure that a minimum 55% overlap.

- Apply 100mm or 150mm wide 2 ply PE/Butyl rubber outer-wrap compliant with DVGW EN 12068 Class C 50°C (DENSO R23 on similar product approved by the Engineer).

The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

The tape shall be applied to a minimum width of 50mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

- Holiday detection shall be carried out in accordance with NACE RP0188.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for joint repairs

Damaged areas on coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer. Hand or power cleaning can be used for small repair areas such as pinholes and areas inaccessible for blast cleaning. 80 Grit or coarser sandpaper can be used to suitably roughen and abrade the area to be prepared. The area shall be sanded to the substrate taking care not to polish the substrate.

Only Engineer approved DVGW Certified and or other Engineer approved certification materials may be used. All materials shall comply with the requirements of EN 12068 Class C HT50°C UV for either tapes and heat shrinkable sleeves (HSS), unless otherwise approved by the Engineer.

An ISO 17050-1 Certificate of Conformity from the supplier (point of origin) stipulating compliance with all chemical, physical and mechanical properties of the applied product, as per ISO 10474 or EN 10204 Inspection Certificates 3.1.B and 3.1 shall be submitted to the Engineer i.e. the DVGW Type Test Report and in-house batch testing for the batch(s) to be supplied.

Pipeline field joint repairs (FJR) may not commence without an Engineer approved Inspection and Testing Plan (ITP) document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures and Quality Control Procedure (QCP).

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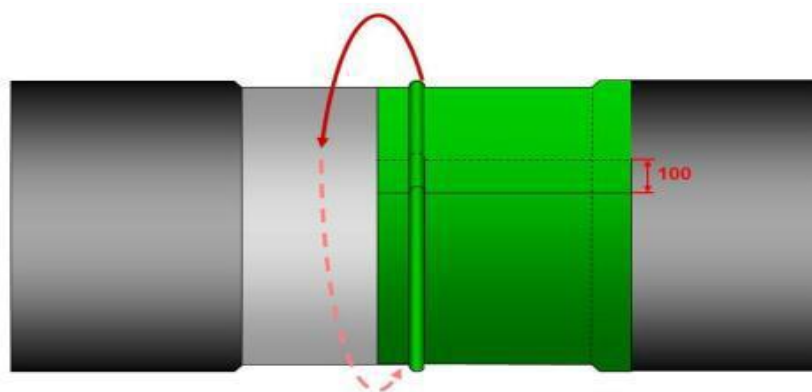
Subsequent to the approval of the documentation detailed above, a Procedure Qualification Trial (PQT) shall be carried out, to be witnessed by the Engineer's representative. The PQT shall include the application of the FJR and subsequent inspection/testing of its properties, to confirm that the Application Procedure Specification (APS) is adequate to produce a FJR system with the specified properties and shall be carried out prior to the start of production.

Alternatively for RPU mainline coatings, the same RPU material can be applied, once the Engineer has approved the APS, QCP and ITP. An ISO 17050-1 Certificate of Conformity from the RPU supplier (point of origin) stipulating compliance with all chemical, physical and mechanical properties of the applied product, as per ISO 10474 or EN 10204 Inspection Certificates 2.1 and 2.2 shall be submitted to the Engineer i.e. the EN 10290 Type Test Report and in-house batch testing for the batch(s) to be supplied as per EN 10290.

PLQ 13.2 FBMDPE, 3LPE and RPU coating (Stopaq viscoelastic wrappingband application)

As an alternative to PLQ 13.1, the unprotected area at welded joints shall be protected against corrosion as follows:

- The cutback of the coating shall be 100 mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- Abrasive blast clean to Sa 2,5
- Degrease using isopropanol alcohol and a cloth.
- Apply first Stopaq Wrappingband CZH [minimum thickness of 1,5 mm] such that there is a minimum of 50mm overlap over the weld and a minimum of 50mm overlap over the coating.
- Where the end of the Wrappingband meets the beginning, peel back the first 100mm of the release foil such that the end can be applied over the beginning with a 100mm overlap.



- Remove the remainder of the release foil and then apply the second Wrappingband in the same manner and remove release foil.

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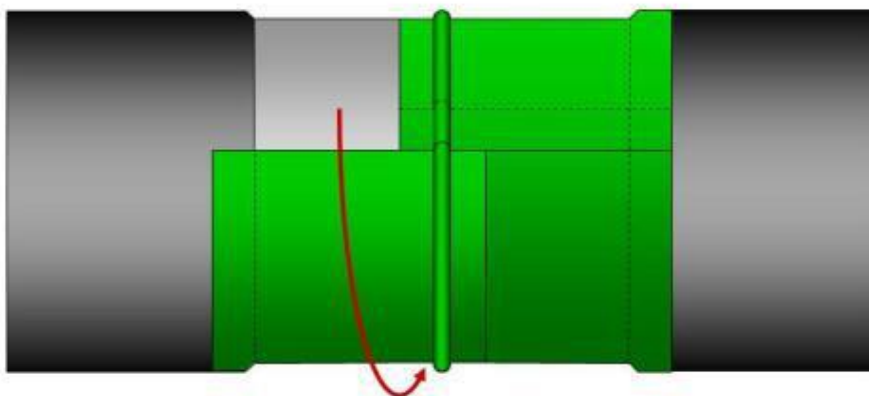
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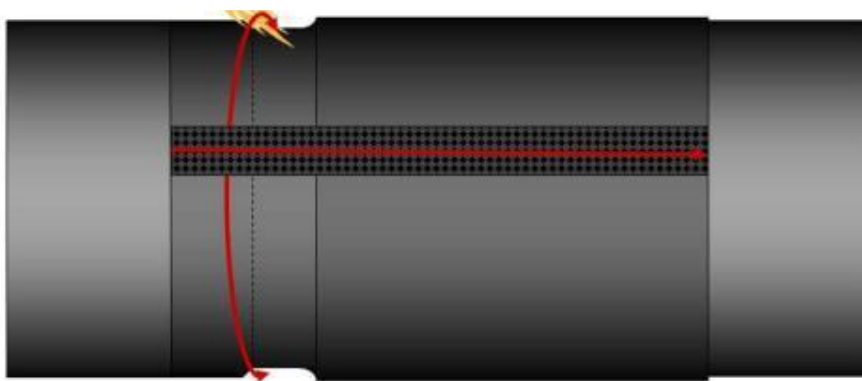
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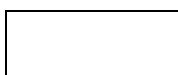
- After removing the release foil, rub the Stopaq by hand to release any trapped air and spark test with 15kV.
- Position the High Impact Shield (HIS) at the 10 o'clock position and wrap around the pipe such that a 100mm overlap results at the joint.
- The HIS shall extend 50mm either side of the Stopaq coating overlap.
- Centre and apply the closure strip on the seam of the HIS. Heat the closure strip and tap on it until attachment is complete. Do not use a siliconized roller.
- Apply heat working from one side to the other against the wind. Apply full heat (100%) to the area there is no Stopaq beneath the HIS.
- Apply 75% heat to area where Stopaq is present beneath the HIS.



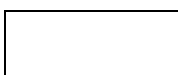
- Immediate backfill after application if possible.
- Holiday detection shall be carried out in accordance with NACE SP0188.
- Damaged areas on coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer.

PLQ 13.3 Polymer Modified Bitumen (Bituguard) Coating

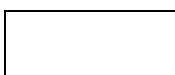
The unprotected area at welded joints shall be protected against corrosion as follows:



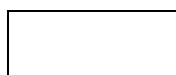
Contractor



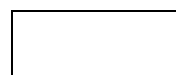
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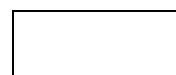
Witness 2



Employer



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- Where applicable, remove the whitewash for a distance of 150mm from the edge of the factory applied coating. Ensure the end of the factory coating is firmly adhered. Cut back any areas of loose or damaged coating to 10mm beyond the area of damage. Ensure the edge of the factory applied coating is bevelled at 30° or less.
- Chamfer any raised edges or steps in the factory coating.
- Surface preparation shall be abrasive blast cleaning to Sa 2,5 of ISO 8501-1. The white wash on the factory coating to be removed for a distance of 100 mm from the end of the coating.
- The steel surface and 100 mm of the factory coating on both sides of the joint to be coated with Bitumen Primer (Denso Primer D or similar product approved by the Engineer).
- Using hot air or gas torches, apply custom sized Hot Applied EN 10268 Class B HT50°C Bitumen rolls of membrane to achieve the same minimum thickness as the factory applied coating with a minimum thickness of 5 mm. Densotherm HD heat applied bitumen wrapping is also acceptable. The applied membrane shall overlap onto itself or the factory coating by a minimum of 50 or 100mm respectively.
- Ensure a liquid bead of coating is maintained in contact with the steel at all times to prevent air entrapment. The perimeter of the field joint shall be neatly finished off and blended into the factory coating.
- The finished joint shall be free of air bubbles and shall exhibit the same bond to steel as the factory coated pipe.

Joint preparation shall be subject to witness and hold inspection by the Engineer prior to application of the primer and coating. The finished joint shall be holiday tested at 15kV and any holidays repaired.

PLQ 14 CUT BACK AT PIPE ENDS

Only if it is expected that the pipes will be exposed to corrosive conditions for long periods before it is installed, the unprotected grit blasted bare steel surface at the ends of pipes, specials and fittings to be welded on site shall be painted with a temporary paint product in the factory, to prevent corrosion of the pipe end before the permanent joint corrosion protection is applied on Site. Alternatively, the uncoated steel surface could be temporarily protected by a pressure sensitive tape. The temporary paint and remains of the tape (after being removed by hand) shall be completely removed by abrasive blast cleaning as part of the surface preparation process. For each project the Contractor shall consult with the Engineer whether the temporary paint on the pipe ends is required.

PLQ 15 UV PROTECTION

All pipes with FBMDPE, 3LPE or Bituguard coatings shall be painted with a white PVA or acrylic (to be approved by the Engineer) for protection against UV. The overcoat to be maintained by applying additional layers until the pipe is backfilled.

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PLQ 16 ADDITIONAL EXTERNAL PROTECTION FOR PIPES CAST INTO CHAMBER WALLS

After the concrete has cured for 7 days, wire brush or scabble the exterior and interior surfaces of the wall to remove laitance. Dry brush to remove all loose powder.

Mix ABE Super Laykold and water (1:1 ratio) and apply as a primer to the concrete and the pipe surfaces. After 1 hour apply a thick coat of ABE Super Laykold to the concrete and the pipe and immediately embed 250mm wide ABE non-woven polyester membrane “SBP” into the Super Laykold. After 3 hours apply another coat of Super Laykold.

Similar products approved by the Engineer can also be used.
This additional protection is required on the inside and outside of chamber walls.

There must be no contact between the steel pipe and the chamber reinforcement.

PLQ 17 JOINT BETWEEN EPOXY LINING AND CEMENT MORTAR LINING

The joint between epoxy lining and cement mortar lining shall be protected as follows:

- Unprotected steel surface to be abrasive blast cleaned to Sa3.
- Epoxy lining to be light abrasive blast cleaned to a surface profile of 60 – 85 micron over a distance of 50 mm minimum.
- Pro-Struct 617NS mortar filler to be applied into the joint between the epoxy and the cement mortar and finished to a smooth surface at a 45-degree angle to the pipe surface.
- Epoxy paint (approved by the Engineer) to be applied on the blast cleaned steel surface, the Pro-Struct 617NS mortar filler and on the cement mortar lining for a minimum distance of 50mm, with a minimum dry film thickness of 500 micron.

PLQ 18 MEASUREMENT AND PAYMENT

If corrosion protection and painting is not measured separately in the Bill of Quantities, the price for corrosion protection and painting shall be deemed to be included in the price for the pipes, fittings and specials.

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PLS: CEMENT MORTAR LINING OF PIPELINES

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PLS 1 SCOPE

This specification covers the cement-mortar lining of steel pipelines.

PLS 2 MATERIALS

PLS 2.1 Cement

- a) Cement shall comply with the latest requirements of SABS ENV 197-1 Type CEM 2A.
- b) Pozzolan material shall not be used in addition to or to replace a portion of the cement.
- c) Cement used for the trial mortar mix to be specified in the tender and all cement used for this contract shall be produced from the same factory unless otherwise permitted by the Engineer in writing. The name of the factory shall be stated by the tenderer.
- d) Cement shall be from the same order of delivery. All cement in storage for longer than eight (8) weeks and all cement in unsealed pockets shall be removed from storage and be discarded.
- e) Cement shall be delivered to the site in a dry condition undamaged by exposure to the weather and shall be stored on the site in approved weather and damp-proof conditions. The floor shall be at least 300 mm above ground-level and covered with a waterproof membrane.
- f) All cement spilled from broken pockets on working surfaces or storage floors shall not be used on the work. It shall be swept up each day and removed from the work together with all broken pockets of cement.

PLS 2.2 Sand

- a) Sand for cement-mortar shall be river sand, natural pit sand, crusher sand or a blend of the sands provided it is clean and the grains are inert, hard, durable and uncoated. The supplier and type of sand and its typical grading envelope shall be stated by the tenderer.
- b) Sand shall be well graded and a sieve analysis of a representative sample carried out in accordance with SABS method 829 shall show that it complies with the following grading requirements:

Sieve size (mm)	Percentage passing by mass
1,180	100
0,075	0 to 10

- c) Sand shall be free from injurious amounts of dust, clay lumps, shale, soft or flaky particles, mica, loam, oil, alkali, and other deleterious substances. The maximum percentage by mass of deleterious substances shall not exceed the following limits:

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Deleterious substances	Percentage by mass
Shale	1
Clay lumps	1
Mica and other deleterious substances	2
Sum of all deleterious substances	3

- d) The water demand of the sand is defined as the quantity of water in litres required to make one cubic metre of a mortar which having a sand to cement ratio by mass of 1,0 has a consistence of 8,5 mm DB penetration when tested in accordance with BS 4551 : 1980. The water demand of the sand shall not exceed 340 l/m³.
- e) The water demand of the sand shall be determined from at least three trial cement-mortar mixes each of a different water content and shall be stated by the tenderer.
- f) Sand tested for organic impurities in accordance with SABS Method 832 shall yield a test solution not darker in colour than the reference solution.
- g) The chlorine content of the sand determined by SABS Method 830 shall not be greater than 0,01 per cent (mass/mass).
- h) The Contractor shall submit samples of the sand to the Engineer for his approval before use. Prior to commencing the work the Contractor shall submit a report in detail from an approved testing laboratory showing that the sand complies with the specification.
- i) The testing laboratories of the SABS, CSIR, CCI, or other laboratories subject to the prior approval in writing of the Engineer, will be accepted as approved laboratories in which tests or designs required by the specification may be carried out.
- j) Sand shall be stored on site on an impermeable surface, protected from the weather, and washed sand shall be allowed to drain freely for at least 24 hours before use. The Engineer may require the Contractor to test the sand daily (or more frequently if necessary) for moisture content, impurities and grading before use.

PLS 2.3 Water

Water for mortar shall be clean and free from injurious amounts of dissolved mineral salts, organic matter or other substances which may impair the strength or durability of the mortar and shall generally conform to the recommendations in the appendix to BS 3148.

PLS 2.4 Admixture

- a) Admixture is any other material apart from cement, sand and water that is added to the cement-mortar or painted onto the bare steel surface prior to cement-mortar application.
- b) No admixture shall be used that has a deleterious effect on the electrochemical passivation of the steel surface by the cement-mortar or on the water flowing in the pipe after the lining has been placed. In addition chloride based admixture or admixture that amperes the durability, fatigue strength or ability of the mortar to resist impact loadings shall not be used.
- c) Prior written approval of the Engineer shall be obtained for the use of any admixture and the Contractor shall submit test data to substantiate the admixture performance.

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PLS 2.5 Welded Steel Fabric

Welded steel fabric shall conform to SABS 1024, except that wire diameter and mesh sizes shall conform to this Specification.

PLS 3 CEMENT-MORTAR FOR LINING

PLS 3.1 Composition

Cement-mortar for steel pipe lining shall be composed of cement, sand, water, and if required, admixture, that are well mixed and of proper consistency to obtain a dense, homogeneous lining of the required thickness that will adhere firmly to the pipe surface.

PLS 3.2 Proportions

- a) The mortar mix shall be designed to produce mortar which will attain the specified compressive and flexural strengths and which will in addition have high density and impermeability.
- b) Cement-mortar shall have a maximum water to cement ratio by mass of 0,36:1 and a maximum sand to cement ratio by mass of 1,5:1 (for drag trowel and hand application) and 2:1 (for centrifugal span lining).
- c) The workability of the mortar shall be the consistence measured by the dropping ball penetration test carried out in accordance with BS 4551:1980.
- d) The proportions of cement, sand and water shall be based upon laboratory tests made with the cement, sand and water to be used on the work. These proportions together with the design workability shall be stated by the tenderer.
- e) The exact proportions of the constituents shall be determined by the characteristics of the sand used, the condition of the cleaned pipe surface, the thickness of the lining, the size of pipe and the lining equipment used.
- f) Two mortar mixes shall be designed: one suitable for machine application and one suitable for hand application where machine application is impracticable. Guide workability levels for designing these mixes are a 9 mm penetration and a 6 mm penetration respectively.
- g) The Contractor shall timeously submit a report of the proposed cement-mortar mix designs to the Engineer for his approval before the work begins. This report, from an approved testing laboratory, shall show that the mixes comply with the specification and shall give for each design mix for at least three different water contents, one of which corresponds to the design workability level stated in the tender, the consistence obtained when using the materials proposed for the work.

PLS 3.3 Strength

- a) The mortar compressive and flexural strength shall be determined from 160 mm by 40 mm prisms stored, demoulded, cured and tested in accordance with the "ISO" SABS method

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866. High frequency (200 Hz) vibration shall be used to compact the mortar when moulding in order to expel all the air entrained when mixing. A minimum period of 2 minutes shall be used.
- b) The minimum 7-day compressive and flexural mortar strengths below which not more than 5 per cent of results may fall are 30 MPa and 5,5 MPa respectively. The corresponding 28-day mortar strengths are 42 MPa and 6,5 MPa respectively.
 - c) At least 6 representative mortar prisms shall be made for each day of machine lining applicable. Three of these prisms shall be tested at 7-day's age and 3 at 28-day's age. The 6 prisms shall be made from one batch of mortar sampled whenever possible from the hopper of the lining machine.

PLS 3.4 Batching, Mixing and Workability

- a) All mortar shall be batched and mixed in mechanical mixers of good condition under the supervision of a competent and experienced person.
- b) All materials shall be batched by mass and the combined error in weighing the materials shall not exceed 2 per cent. Equipment performance shall be checked when required by the Engineer and the Contractor shall provide apparatus as required for this testing.
- c) All weighing and measuring equipment shall be checked daily, and if necessary adjusted, before cement-mortar mixing commences.
- d) The quantity of water used in each batch of mortar shall be carefully adjusted to maintain the cement to water ratio required for the approved mix.
- e) Allowance must be made for the moisture content of the sand which shall be determined either by weighing and drying or by the speedy moisture meter. Allowance shall also be made for moisture collecting on the interior of pipe surface, the method of transporting the mortar from the mixer to the lining machine and the trowelling system used.
- f) Mixing shall be continued for not less than 90 seconds after all the materials including water are in the mixer. All mortar shall be thoroughly mixed and the whole of each batch shall be uniform, free of lumps and free from segregation. The minimum time of 90 seconds may be increased at the discretion of the Engineer.
- g) Adequacy of mixing shall be judged visually and if in the Engineer's opinion mixing is unsatisfactory, the mixer shall be replaced by a machine which will produce acceptable mixing.
- h) Any batch not complying with the specification shall be removed from site or disposed of as directed by the Engineer or Inspector.
- i) The workability of the freshly mixed mortar shall be determined periodically from a sample taken immediately prior to being transported to the lining machine, or where practicable from a sample taken at the lining machine itself.
- j) There shall be no retempering of the mix after discharge from the mixer. Only fresh mortar shall be used, mortar in a mixed state for longer than 1 hour shall be discarded.

PLS 3.5 Once the optimum workability for the day's run is determined the consistence shall not vary by more than 1 mm DB penetration.

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PLS 4 ACCESS OPENINGS AND ACCESS POINTS FOR IN SITU APPLIED LININGS

PLS 4.1 The Contractor shall provide access openings in the pipeline for inspection, cleaning and lining work by cutting out a suitable section of piping. On completion of the lining operation, the Contractor shall replace the relined cut out section by means of electric arc welding carried out in accordance with the requirements of Section PLN of the Particular Specification.

The average spacing and dimension of the access openings required shall be stated by the tenderer.

PLS 4.2 Welding can be inspected by means of ultrasonic or radiographically testing. This inspection will be carried out in accordance with BS 3923 and API 1104 by an inspection authority appointed by the Engineer. All defects not complying with API 1104 shall be ground out and repaired to the approval of the Engineer. The costs of all repairs and consequential inspection shall be borne by the Contractor.

PLS 4.3 The actual position of each opening shall be sited so that it does not interfere with anchor blocks, valve chambers, scour piping, etc., and so that it does not cause an obstruction to traffic, access to properties, structures etc. The position of each access opening to be approved by the Engineer. Access openings shall not interfere with pipe joints, expansion joints, etc.

PLS 4.4 An access point is an opening to the pipe interior such as an access manhole or large diameter air valve saddle. It may be used for inspection, cleaning, cement-mortar lining or curing as required by the Contractor in which case it becomes his responsibility to control all access at the point until the blank flange and/or air valve is refitted and bolted up by the Contractor prior to filling the pipe with water.

PLS 4.5 The Contractor is responsible to prevent animals, reptiles, etc. from entering the pipe.

PLS 5 CLEANING PIPE SURFACES

PLS 5.1 The Contractor shall clean the steel surface to be cement-mortar lined so as to provide a clean, firm and sound surface free from contaminants such as loose rust, loose mill scale, weld slag, loose corrosion products, dust, soil, grit, oil, grease, accumulations of water and water soluble salts, which can adversely affect the adhesive bond of the freshly applied mortar and the electrochemical passivating mechanism of the cement-mortar.

PLS 5.2 Mechanical cleaning by hand or machine methods or both shall be used. Details of the method and equipment to be used for cleaning shall be submitted with the tender. Solvent emulsions shall be used to remove oil or grease followed by thorough rinsing with clean water. Compressed air tools or equipment used inside the pipe, shall be fitted with an adequate oil removal filter and moisture drain trap which shall be inspected and cleaned regularly.

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- PLS 5.3** The interior surface of the installed pipeline shall be cleaned to a degree of cleanliness equivalent to preparation grade St 2 of SABS Method 767 (thorough scraping and wire brushing).
- PLS 5.4** At the start of the contract after cleaning but before any lining is carried out a standard of cleanliness for the pipe surface which is assessed for freedom from dust and debris using transparent cellophane tape in accordance with SABS Method 769 is to be agreed upon between the Engineer and the Contractor and will be strictly adhered to for the duration of the contract.
- PLS 5.5** Cleaning of the pipeline surfaces shall be completed not less than one day or more than two days in advance of the lining operation and no lining shall be carried out unless the cleaned surface has been inspected and approved by the Engineer.
- PLS 5.6** Immediately prior to the machine application of lining, excessive condensation and pools of water, rust dust, sand, mud, loose mortar, rebound debris and other foreign materials that have accumulated since the cleaned pipe section was inspected and approved shall be removed by suitable methods that are to be agreed upon before the lining is applied.
- PLS 5.7** The Contractor shall provide 60 watt halogen or 20 watt fluorescent lamps to illuminate the cleaned pipe and provide suitable movable lamps to illuminate the surfaces when the Engineer carries out testing and inspection.
- PLS 5.8** The Contractor shall provide his workmen and the Engineers representative with protective clothing and appliances such as dust respirators, goggles, face shields and masks to prevent bodily harm while carrying out the cleaning operation.
- PLS 5.9** Cleaning water, rust and debris removed from the pipeline shall be collected, loaded and transported at a maximum of 3 day intervals but should the local accumulation become excessive it shall be removed at shorter intervals as determined by the Engineer.

Dirty cleaning water shall not be disposed of in a manner that will cause soil erosion in the working area. The rate for cleaning shall include for collecting, loading, transporting and disposal of the cleaning water, rust and debris at permanent disposal sites.

PLS 6 APPLICATION OF MORTAR LINING

PLS 6.1 Machine Application of Mortar Lining

- a) For shop applied linings pipes shall be adequately supported.
- b) The lining shall be applied in one layer by use of a machine with an applicator head which will centrifugally or otherwise place mortar against the surface of the pipe without injurious rebound and with sufficient velocity or pressure to cause the mortar to be densely packed and to adhere in place. Details of the machine to be used shall be submitted in the tender. The use of compressed air in direct contact with the cement-mortar will not be permitted in

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the process of mixing or application. The rate of travel of the machine and the rate of discharge of mortar against the wall of the pipe shall be entirely mechanically controlled so as to produce a smooth lining of uniform thickness through the interior of the pipeline. The lining machine shall be provided with attachments for mechanically trowelling the mortar. Both the application and trowelling of the mortar shall take place at the rear of the machine so that the freshly placed and trowelled mortar will not again be disturbed or touched until after it has set. The trowel attachment shall be such that the pressure applied to the lining will be uniform, producing a smooth surface without shoulders or undulations, and producing a lining of uniform thickness.

- c) The Contractor shall only be permitted to place a double layer (or skin) on approval of the Engineer. A double layer (skin) shall be placed within 24 hours after the first layer has been placed. A minimum layer thickness of 5 mm is required. The total cost for a double layer will be for the account of the Contractor.

PLS 6.2 Centrifugal spun lining of pipes

The coating, if applicable, shall be suitably protected against mechanical damage during the handling and spinning operations. Before being placed in the spinning machine, the pipe shall be suitably braced with external stiffening rings, which shall not be removed until the appropriate one of the following periods has elapsed from the time of placing of the lining:

- a) 72 hours when water curing is used.
- b) 36 hours when steam curing is used.

End gauge rings shall be securely attached to the pipe ends to control the lining thickness, to act as a stop end to prevent mortar leakage and to stiffen and hold the pipe ends round.

Each pipe shall be rotated in a spinning machine with its axis horizontal during and for a suitable period after the placing of the lining. The speed of rotation shall be such as to produce a uniform distribution of the cement mortar over the interior surfaces of the pipe. Sufficient mortar to line completely one pipe to the appropriate nominal thickness shall be mixed in one batch, and it shall be of such consistency as to minimise segregation during spinning. The mortar shall be placed in the pipe immediately after mixing and before initial set has taken place, and in a manner providing uniform longitudinal distribution of the batch from end to end of the pipe. As soon as the mortar lining has achieved a uniform thickness over the whole interior surface of the pipe, the speed of rotation shall be increased to a speed that will compact the mortar and is not less than a peripheral speed of 17 metres per second. The required speed shall be maintained for such a period as will give the maximum density of mortar and smoothness of surface, and sufficient bonding to permit removal of the pipe from the machine without injury to the lining. All water and latence expelled during spinning shall be removed in such a manner that the surface of the lining is smooth, level and true.

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After the lapse of a suitable period after spinning (as determined by experiment), the spun lining shall be given a steel trowelled or smoothing bar finish. A second towelling may be necessary to remove all laitance and produce a smooth and hard finished surface.

For spigot and socket joints, the concrete lining shall be ended as shown on Figure 1 at the end of this specification.

PLS 6.3 Pipe Ends for Shop Applied Linings

For flanged pipes and specials and pipes intended for jointing by couplings, concrete lining shall be ended flush with pipe ends with a 6mm bullnosing of edges by means of a nosing tool.

For pipes to be butt welded, the lining shall terminate 50 mm from the internal end of each pipe and the end of the lining shall be bevelled to form an undercut angle of approximately 85 degrees between the clear end of pipe barrel and the lining end. The unlined surface of 50 mm wide from each end may be protected by strips of pressure sensitive plastic tape, firmly pressed into the surface to exclude all air, moisture and to give temporary protection between the works and butt welding on the site.

For spigot a socket joint with a fillet weld, the cement mortar shall end as shown on figure 1 attached.

PLS 6.4 Hand Application of Mortar Lining

- a) In addition to the repair of but welded joints, hand applied mortar shall be allowed only where machine application is impracticable. Bends less than 22,5° shall be lined by machine unless stated by contractor in the tender to the contrary. The Engineer may order the correction of defective lining to be carried out by hand application of mortar lining.
- b) Any voids related to flexible couplings will be filled by hand with mortar and finished flush with inside wall of pipe prior to application of mortar lining.
- c) Areas to be hand lined shall be cleaned and all dust removed with a soft wire hand brush.
- d) Cement slurry shall be applied to the cleaned pipe and existing cement lining as a bond coat in a layer no more than 2 mm thick after wetting the existing lining.
- e) Cement slurry consist of cement, water and admixture. A suitable admixture is a styrene-butadiene copolymer latex (SBR) manufactured for use with Portland Cement as a bonding agent (Nitobond or Duralatex or a similar product approved by the Engineer). The proportion of cement, water and admixture shall be in accordance with the manufacturer's specifications and submitted to the Engineer.

A typical proportion is a SBR/Water mix of 1:1 and add cement to form a slurry consistency.

- f) The cement-mortar shall be applied before the slurry is dry. Admixture shall be used in the cement mortar and the proportion shall be in accordance with the manufacturer's

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specifications and submitted to the Engineer. A typical proportion is a SBR/Water mix of 1:3 added to the cement/sand mix.

- g) Hand applied mortar shall be finished with steel trowels and the quality, thickness, uniformity and surface finish shall be substantially equivalent to the machine applied mortar lining.

Care shall be taken to maintain full lining thickness at the intersection of branch and pipeline barrels.

- h) All hand finishing work in a section of pipeline, including hand patching of defective lining, shall be completed within 24 hours after completion of the machine application of mortar lining to that section. If necessary application of mortar lining by machine shall be delayed or stopped to assure compliance with this provision.
- i) The cost of hand application of mortar lining and all hand finishing work shall be included in the rate for lining.
- j) Hand applied linings of specials (bends, tees, reducers, etc.) of nominal diameter 600 mm and larger to be handled or transported after application of the lining and windows at access openings for all pipe diameters shall be reinforced by tack-welding 100 mm x 50 mm x 2,5 mm diameter steel mesh to the inside of the pipe in such a way that it is not in contact with the pipe except where welded. The minimum cover over the mesh shall be 10 mm.

PLS 6.5 Spigot and Socket Joints for steel pipes

Refer to Figure 1 at the end of this specification

At spigot and socket pipe ends the internal protection shall be done in accordance with the following:

- Prior to the joining of the pipes the vertical surfaces of the cement-mortar lining and the steel surfaces of both pipes shall be coated with a slurry. Mix a bonding agent (Supercrete from Samson or a similar product approved by the Engineer) with water (2:1 ratio) to form the slurry. The surface of the cement-mortar must be wet when it is coated with the slurry. Mix the slurry with an expansive cementitious grout (Standard Bedding grout from Samson or a similar product approved by the Engineer). While the slurry is still wet the grout shall be trowelled to the vertical surface of the cement-mortar lining in the socket.
- Alternatively mix Multibond SBR 1070 with water (1:3 ratio) to form a slurry. Mix cement with sieved plaster sand (1:1 ratio). Add the Multibond/water slurry to the cement/sand mix (1:3 ratio) to form a mortar. Apply the Multibond/water slurry to the steel surfaces and wet vertical surfaces of the factory cement mortar lining and wait till it is tacky and then apply the mortar to the vertical surface of the cement-mortar lining in the socket.

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- Push the spigot into the socket and tack weld. The excess grout which has been squeezed out of the joint shall then be removed from the pipe and the joint shall be smoothed with scraper or a sponge on a rope where man access into the pipe is not feasible. Complete the welding before any movement at the joint is allowed and while the grout is still wet.
- The joint shall be welded at low amps and with thin rods to reduce the temperature of the steel at the grout.

All mix ratios above are per volume.

The Contractor shall keep the joint covered with wet hessian on the outside until it is covered with soil to ensure proper curing of the mortar.

The Contractor shall conduct tests to determine the optimum jointing procedure and to proof that the above methods are producing satisfactory results (to the satisfaction of the Engineer) before installation of the pipes commences. If the pipeline is not accessible for visual internal inspection of the joints, the Contractor shall conduct CCTV inspections of the joints immediately after the completion of the first ten joints and a regular basis thereafter to proof the quality of the joint repairs.

PLS 6.6 Moving of pipes

Lined pipes shall not be moved for a period of 7 days and not be transported for a period of 14 days after completion of the lining. Covers on both pipe ends are required during transport and storing at the factory and on site. The manufacturer of the pipes shall ensure that covers remain intact and on the pipe ends at the factory and during transport and off-loading on site.

PLS 7 THICKNESS AND SURFACE FINISH OF LINING

PLS 7.1 The minimum mean thickness of the lining shall be 12 mm per measurement station. The range of mean thickness shall be between 12 and 15 mm. A lining with a thickness of less than 7 mm at any point is unacceptable. The thickness of lining on specials shall generally comply with the above provided that the minimum cover of mortar over reinforcement shall not be less than 10 mm. The maximum unbiased standard deviation of thickness shall be 3 mm. The thickness statistics shall be calculated for each measurement station and for all stations in a pipe section between access openings.

PLS 7.2 The finished surface shall be uniformly smooth with no trace of sand or gritty particles. After trowelling the finished surface shall be examined by the Engineer or his representative for quality, and the Contractor shall provide adequate interior lighting for this purpose. The Contractor shall request all inspections in writing once the Contractor has executed his own quality control

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inspections and must give the Engineer at least 48 hours' notice of his inspection requirements. Adequate time must be allowed for the Engineer to carry out the inspections.

Ridges or uneven build-up caused by irregularity in the travel rate of the machine shall be a cause for rejection of a lining. A "pock mark" or "orange peel" effect shall also be a cause for the rejection of a lining. In all cases the Engineer's decision on quality will be final.

PLS 7.3 The lining shall be well finished with a smooth surface free from excessive laitance and surface irregularities. Projections exceeding a height of 1,5mm shall be removed by trowelling before the cement-mortar has set, or by grinding after the lining has cured.

The thickness of the laitance, if any, shall not exceed 10% of the thickness of the lining, or 1,25mm, whichever is less.

PLS 7.4 The lining surface finish will be measured using a 305mm long straight edge and a 1,6 mm feeler gauge. At each measurement station the gaps between the lining and a straight edge laid parallel to the pipe axis at opposite ends of the pipe diameter, shall be checked to see if they are greater than 1,6mm. Any one or more gaps bigger than 1,6 mm will result in a failure being recorded for that straight edge location.

PLS 7.5 The ends of only one pipe diameter at each measurement station shall be checked for surface finish and this diameter shall change in a clockwise rotation of 45 degrees to the adjacent diameter at the next measurement station. The surface finish pass rate for a pipe section is the number of straight edge locations measured less the number of failures, expressed as a percentage of the measured locations.

The lining surface finish shall be free from excessive number of defects and shall have a minimum pass rate of 50 percent.

PLS 8 CURING

PLS 8.1 Curing operations shall begin immediately following completion of machine mortar lining of a section of pipeline or the hand mortar lining of an access point, bend, branch, taper, special or access opening. The section of lined pipe shall be sealed off with airtight covers or removable bulkheads over all openings and the lining shall be maintained in a moist condition by the addition of water until in- situ lined pipes are filled with water or for at least 42 days for shop applied linings or up to the date the pipes are delivered to site if it is done between 14 days and 42 days after cement mortar lining. The construction contractor shall be responsible to maintain the cement mortar in a moist condition up to at least 42 days after manufacturing, should the pipes be on site before the expiring of the 42-day period. The method of curing is subject to the approval of the Engineer.

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PLS 8.2 The Contractor shall inspect each section that is undergoing curing daily to ensure it has adequate curing moisture and that all seals are in place. If necessary, water shall be added to maintain a moist lining and any seal found damaged shall be replaced.

PLS 8.3 The exterior surfaces of pipe exposed to sunlight shall be covered with a minimum of three layers of hessian which shall be sprinkled with water and kept damp in the daytime during the period of lining, finishing and curing so as to prevent cracking of the lining due to temperature effects.

PLS 8.4 During curing period steps shall be taken when necessary to prevent the temperature of the steel shell falling below 2°C.

PLS 8.5 Steam Curing of Shop Applied Linings

The Contractor has to prove that the pipe coating will not be damaged during steam curing.

Immediately after application of the cement-mortar lining, the ends of the pipe shall be completely sealed. After the lined pipe has been standing for not less than 2 hours, steam shall be so injected into it as to raise the temperature at a rate not exceeding 28°C per hour until the temperature of the lining is within the range 55-70°C. Steaming shall continue for a further 6 hours, the temperature of the lining being maintained within the range specified. Steaming shall be discontinued, and the pipes shall remain sealed for a further 2 days from the time that the temperature of the pipe has fallen to ambient. During this period precautions shall be taken to prevent the temperature of the steel falling below 2°C.

During the curing cycle, excluding the 2-day holding period, the temperature of at least one pipe out of that day's production, shall be recorded by a suitable automatic recording instrument. If the temperature record reveals that the requirements set out above have not been achieved, then the pipes shall be subjected to the full curing period of at least 7 days.

PLS 8.6 The manufacturer must ensure that the type and quality of the pipe end covers is adequate to ensure it remains intact during storing, transporting and handling.

PLS 9 INSPECTION OF LINING

PLS 9.1 As soon as the lining has hardened to the stage that it will not be damaged by workmen or their means of transport in the pipe, the lined surfaces shall be inspected for surface finish, thickness and other defects and the defective area shall be marked for repair. The Contractor shall provide facilities for lighting and inspection.

PLS 9.2 The Contractor shall make available a suitable trolley for the sole use of the Engineer and/or his representatives.

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- PLS 9.3** In each pipe section that has been lined and trowelled in a day's run, measurement stations will be marked out at 10 m spacing. The lining at each measurement station will be checked for thickness at 8 points on the pipe circumference, 45 degrees apart starting at the crown of the pipe. The lining thickness at all edges (branches, tees, etc.) will be checked.
- PLS 9.4** The lining thickness will be determined with a handheld eddy current thickness gauge supplied by the Contractor that has been calibrated against known thicknesses of mortar taken from the same day's batch of mortar. The thickness gauge will also be used to locate and mark areas of lining between measurement stations that are too thin or too thick.
- PLS 9.5** The cured lining of each pipe and special applied in a shop shall be inspected visually for defects before the pipe leaves the factory.
- PLS 9.6** The inspections and measurements shall be done by the Contractor, to the approval of the Engineer.
- PLS 10 DEFECTS**
- PLS 10.1** Defects in cement-mortar lining which may include but are not limited to sand pockets or porous spots, voids, blisters, excessively cracked areas, excessively debonded areas, areas of lining thinner or thicker than specified, areas of unsatisfactory surface finish and mortar that does not meet the strength requirements shall be repaired by the Contractor notwithstanding that the lined area may previously have been inspected and passed by the Engineer. This may involve the removal of large sections of lining, re-cleaning of the pipe surface and re-lining of the pipe, the costs of which shall be borne by the Contractor.
- PLS 10.2** Small defective areas shall be repaired by manual removal of the defective lining and by hand application of mortar lining within 24 hours after lining application. All defective concrete shall be removed and the surrounding area of concrete chipped back to a position where the concrete is firmly bonded to the steel. In removing the defective lining, the mortar shall be cut back to a square shoulder and no chamfered joints will be permitted. Defective areas encompassing the full circumference of the pipe shall be replaced by machine application.
- PLS 10.3** Cracks bigger than 1,0 mm shall be repaired by brushing and wiping of cement slurry into the cracks.
- PLS 10.4** Defective lining rejected at the time of lining shall be removed before the initial set of the mortar. The removal and disposal of material shall be at the Contractor's expenses.
- PLS 10.5** Defective lining removed from the pipeline, waste cement-mortar from trial mixes, cleaning of pump hoses and equipment, and any other debris from the lining operations, shall be collected and temporarily deposited in a suitable heap or container and shall not litter the site. It shall be transported off site twice a week and disposed of.

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PLS 11 SAMPLES AND TESTS

The cost of supplying samples and making any test shall be borne by the Contractor unless prior arrangement for payment is agreed to in writing by the Engineer. The Contractor is to allow for these costs in his price.

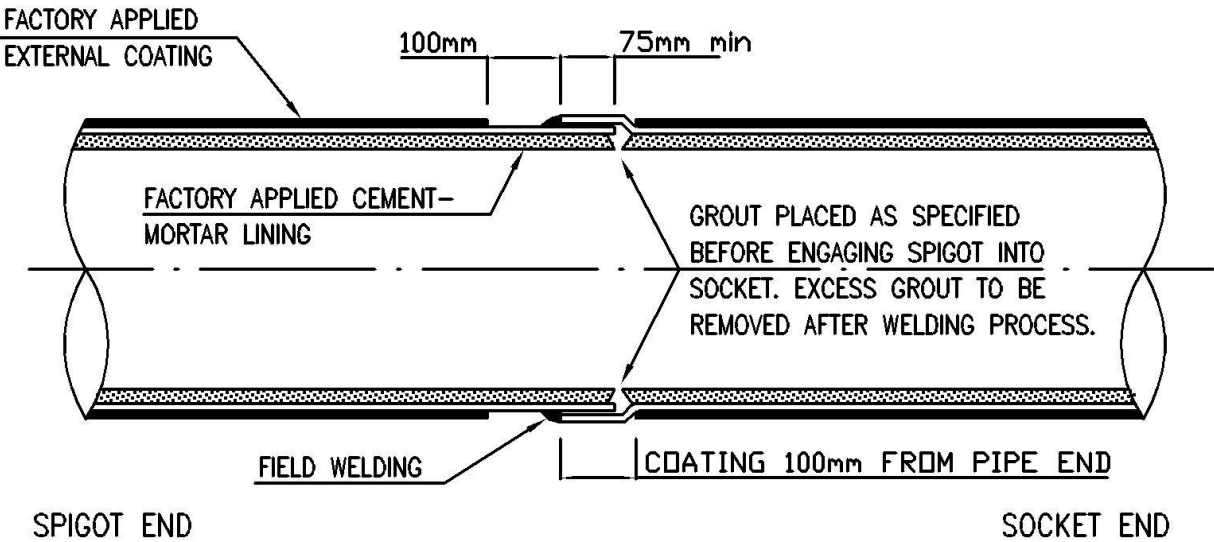
PLS 12 BACKFILLING OF EXCAVATIONS

Backfilling of the excavations may only be carried out after the welding and repair of coating have been approved by the Engineer.

PLS 13 DISPOSAL OF UNDESIRABLE MATERIAL

All material and debris removed from the pipeline shall be loaded, transported and disposed of at approved dumping sites. The removal and disposal of all such material shall be included in the rates for cleaning.

FIGURE 1
SPIGOT & SOCKET PIPE END



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PLT: FLOW METERS (GENERAL)

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PLT 1 SCOPE

This section of the Specification deals with the supply, delivery, installation and commissioning of:

- a) in line ultrasonic flow meters;
- b) clamp on ultrasonic flow meters
- c) flanged mechanical turbine meters
- d) electromagnetic flow meters.

PLT 2 IN-LINE ULTRASONIC FLOW METERS

PLT 2.1 General Requirements

An in-line ultrasonic flow meter will consist of:

- a) Two machined, stainless steel, weld-on sockets with inserted perspex windows, which are held by two plastic flanges secured with stainless steel bolts and spring washers.

The tenderer shall be responsible for the welding of the sockets on to the pipeline, as well as making good all corrosion protection according to applicable specifications.

- b) Two 1 MHz sensing units, connected via co-axial cables of 50 ohms, with a minimum length of 12 m, to the transmitter.

The sensing units are to be removable under full pressure, while the pipeline is operating.

Both sensing units shall be electrically isolated from the pipeline.

- c) A transmitter that shall have two output circuits:
 - i. One circuit for the 4-20 mA output signal to drive an indicator, and if later required a recorder, with maximum load capacity of 1 000 ohm.
 - ii. The second circuit to drive a 24 V integrator, with a 2% zero flow cut off.

All power requirements other than 230 V will have to be provided for by the successful Tenderer.

The transmitter shall have facilities to adjust for the various pipe diameter and flow rates.

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PLT 3 CLAMP-ON ULTRASONIC FLOW METERS

PLT 3.1 General Requirements

Single channel flow meters operated in transit time or time-of-flight mode shall be provided unless otherwise specified. The flow meter provided shall be capable of measuring the instantaneous flow in a pipeline and give the accumulated flow. The installation shall comprise at least two (2) sensing units (transducers) that are connected via co-axial cables and connected to a signal conversion unit. The signal unit shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalize flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

Welding of transducers onto the pipe will not be allowed.

The IP rating for the housing of the transducers shall be *submersible*.

The mountings on the transducers shall be manufactured by stainless steel.

The location of the flow meter installation shall be indicated on the relevant drawings, together with the following general information:

- Pipe outer diameter
- Pipe material
- Pipe wall thickness
- Internal lining
- Average thickness of internal lining
- Fluid to be measured
- Distance between transducers and signal converter
- The operating temperature for all equipment shall be minimum -10°C and maximum 55°C.

PLT 3.2 Flow Accuracy

The flow accuracy (velocity) shall be $\pm 1\%$ of reading for pipe diameter greater than 150mm and flow velocities greater than 0.3 m/s. For pipe diameters smaller than 150mm, the flow accuracy shall be $\pm 3\%$.

The overall rangeability or turn-down ration shall be at least 400:1.

The repeatability for clamp-on transducers shall be 0.2 to 0.5% of full scale reading.

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PLT 3.3 Calibration

The Contractor shall allow for the calibration of the flow meter one month after installation by Technology Services International of Eskom enterprises. A certificate of calibration shall be submitted to the Engineer, acceptance of which signifies final completion of the installation.

PLT 3.4 Guarantee Period

The ultrasonic flow meter shall be guaranteed for a period of at least **24 Months** from date of **successful commissioning**.

PLT 4 FLANGED MECHANICAL TURBINE METERS

PLT 4.1 Equipment Preferred

All mechanical turbine meters shall be type Sensus or similar and approved.

PLT 4.2 Accuracy

All mechanical meters supplied in terms of this Contract shall perform to an accuracy of better than $\pm 2\%$ error over the meters operating range i.e. between Q_t (transitional flow) and Q_n (continuous flow). The performance characteristics of the meters offered shall be equal to or better than the values tabled below:

Size (DN) (mm)	Q_{min} (m ³ /h)	Q_t (m ³ /h)	Q_n (m ³ /h)	Q_{max} (m ³ /h)
40	0.3	0.8	40	60
50	0.3	0.8	50	90
80	0.5	0.8	120	200
100	0.8	1.8	230	300
150	1.8	4	450	600
200	4	6	800	1200
250	6	11	1250	1600
300	12	15	1400	2000
400	25	50	2000	3000
500	45	60	3000	4500
600	100	180	3300	6500
800	210	320	6000	12000

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PLT 4.3 General Requirements

Meters must be fitted with dry dial registers, which comprise 6 digit cyclometer-type totalizers, registering in kiloliters (kl) or m³. These registers must be sealed to prevent ingress of dirt or moisture. The registers, which are to be fitted as standard, must be able to provide one high frequency opto-type pulse output function and two low frequency reed-type pulse output functions. All flow meters shall be provided complete with frequency converter unit and opto coupler. The frequency converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

No consideration will be given to meter types, which necessitate the use of special tools or fitment of any form of gland in the process of connecting pulser units, or, meters which require a register-change to switch from one volume unit per pulse to another. Dismantling of registers for this purpose will not be acceptable. Tenderers are to provide full details of these aspects with their tenders.

Cover bolts must be of stainless steel material to facilitate easy removal of mechanisms. Meter bodies must be coated with a high quality sintered epoxy powder coating, both internally and externally, to provide maximum protection against corrosion.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream for each size of meter offered, to ensure that the accuracy of the meters remain within the stated limits, under normal operating conditions. Preference will be given to meter types requiring a minimum of straight pipe upstream and downstream, as installation space and lay lengths are at a premium.

The performance of the meters offered shall not be affected by outside magnetic influences.

Details of head loss across the meters offered shall be provided by the Tenderer.

PLT 5 ELECTROMAGNETIC FLOW METERS

PLT 5.1 General Requirements

All electromagnetic flow meters supplied under this contract shall be for high measuring accuracy i.e. $\pm 0.5\%$ of reading plus 0.05% of full scale. The repeatability or reproducibility of measurement shall be $\pm 0.1\%$ of full scale. The meter shall have a long term zero stability of $\pm 0.2\%$ and linear variation shall be less than 0.2%.

Contractor

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Electrodes shall be manufactured from a high quality metal and shall be removable for cleaning purposes. Removal of electrodes with the line under pressure is preferred.

The minimum downstream and upstream unrestricted straight pipe run required for the specified measurement accuracy shall be stated by the Tenderer.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

The flow meter shall be equipped with a separate mountable signal converter unit complete with sufficient length of signal cable. The signal converter shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalized flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle supplied under the electrical scope of the Contract.

Electromagnetic meters and converters shall be suitable for outdoor installation and shall be adequately protection against lightning.

PLT 6 DIGITAL INDICATOR/INTEGRATOR

The display shall be a 6-digit, 0.56" (14.2mm) High Red L E D, giving a maximum display of 999999. The decimal point shall be selectable.

A flashing display shall be given during totaliser overflow.

The indicator/integrator shall be powered by 230 V AC at 50 Hz.

The indicator/integrator shall be constructed in such a way that it can be calibrated to the required flow and also by means of a selector button, display the accumulated quantity of water released.

The front bezel shall meet NEMA 4/IP65 requirements

The manufacturer of the indicator/integrator shall comply with ISO 9001 and proof of this to be submitted with the tender documents.

The indicator/integrator shall have a lock-out facility to limit operator entry to the programmable settings and totaliser.

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The totaliser shall have a programmable time base with a scale factor of 0.001 to 100.0 and a low-end cut-out.

The remote indicator/integrator if required is to be fitted into an IP 66 enclosure in such a way that the flow reading is clearly visible with space available for the labelling and surge protection as specified.

PLT 7 INSTRUMENT PANELS

All panels will comply with the minimum requirements for an IP 65 rating.

All cable entries will be fitted with the appropriate cable gland. All cable glands will comply with IP 68.

Each enclosure is to be fitted with an M10 brass bolt and two nuts that will act as an earth bar. All surge protection in the enclosure to be grounded onto this bolt.

a) Local indicator/integrator

An instrument panel is required to house the flow meter power supply unit if required, indicator/integrator and surge protection and shall comply with the following:

1. At least 500 mm high, 400 mm wide and 200 mm deep.
2. Constructed from polycarbonate.
3. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
4. Be fitted with a plain painted metal chassis of at least 2.5 mm thick.
5. Be fitted with a polyester internal door for mounting of the totaliser.
6. The external door shall be fitted with a window that allows sight of the totaliser.
7. The external door shall have an extruded polyurethane seal fitted to a groove.
8. Only two closure points that are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
9. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

b) Remote indicator/integrator (if required)

An instrument panel is required to house the remote indicator/integrator and surge protection and shall comply with the following:

1. Constructed from polycarbonate.



Contractor



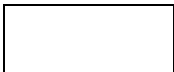
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- 2. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
- 3. Fitted with a polyester internal door or stand-offs for mounting of the totaliser.
- 4. The external door shall be fitted with a window that allows sight of the totaliser.
- 5. The external door shall have an extruded polyurethane seal fitted to a groove.
- 6. Only two closure points which are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
- 7. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

PLT 8 SURGE PROTECTION

Single phase 230 V AC medium protection units that are certified to withstand surges of up to 75kA.

Two wire, 230 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two wire, 24 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two explosion proof, pipeline spark gaps rated to withstand surges of up to 100kA, complete with pipeline mounting brackets and a fly lead of at least 300mm.
All surge protection units must be grounded to a common earth point in the panel that houses the ultra sonic flow meter. If a nut and bolt arrangement is used it shall be at least an M10 and shall be made of brass. Care has to be taken to ensure that the nut and bolt do not negate the IP 65 rating of the enclosure.

PLT 9 SIGNAL CABLE

All signal cable to be 1,5 mm², 4 core, twisted pair, braided screened cable.

PLT 10 EARTHING

The successful Tenderer is to supply 70 mm², stranded copper cable as well as lugs that will fit the cable and an M10 bolt to connect between the equipotential bar and earth mat.

The successful Tenderer is to supply 16 mm², green PVC insulated, stranded copper cable to connect between the common earth at the instrument panel and the equipotential bar.

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PLT 11 EQUIPOTENTIAL BAR

An equipotential bar with cover must be suitably mounted within each flow meter chamber. Modular terminals should be provided to accommodate 3 connections of up to 16 mm², 3 connections of 16 - 95 mm² and 3 for flat connections up to 30 mm wide.

PLT 12 LABELS

Two types of labels are required. One for the site and installation name, the other giving details of the flow meter characteristics.

Labels to be manufactured from plastic engraved stock with white lettering on a black base.

Lettering to be 10 or 6 mm high x 5 and 3 mm wide and labels to be at least 105 mm X 30 mm.

All labels to be fitted with at least two strips of 12 mm wide double sided tape that run for the total length of the label.

PLT 13 GENERAL REQUIREMENTS

All screws, brackets, cable saddles, nuts, bolts, washers etc. used in the installation of the equipment shall be from stainless steel.

Before delivery to site all equipment and all parts supplied under this contract will be checked and certified at the supplier's workshop to ensure that they are in working condition by a delegated representative of the client.

PLT 14 COMMISSIONING

The equipment as supplied under this Contract shall be commissioned after **one fault free month** of operation.

If during this month the equipment or any part thereof should fail the successful Tenderer shall repair the equipment at his own expense and once again leave the equipment to operate for one fault free month before commissioning. All costs incurred shall be for the successful Tenderer's account. This cycle to continue until one fault free month has been attained.

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PLTP: MANUFACTURE, SUPPLY AND TESTING OF THERMOPLASTIC PIPES

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PLTP 1 SCOPE

This Specification covers the manufacturing, supply, installation and testing of thermoplastic pipes and fittings.

PLTP 2 STANDARDS

The latest revisions of the following Standards shall be applicable.

COMMONLY USED STANDARDS FOR PLASTIC PIPING SYSTEMS	
SANS 15874-1	Plastics piping systems for hot and cold water installations - Polypropylene (PP) Part 1: General
SANS 15874-2	Plastics piping systems for hot and cold water installations - Polypropylene (PP) Part 2: Pipes
SANS 15874-3	Plastics piping systems for hot and cold water installations - Polypropylene (PP) Part 3: Fittings
SANS 15874-5	Plastics piping systems for hot and cold water installations - Polypropylene (PP) Part 5: Fitness for purpose of the system
SANS 15875-1	Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X) Part 1: General
SANS 15875-2	Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X) Part 2: Pipes
SANS 15875-3	Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X) Part 3: Fittings
SANS 15875-5	Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X) Part 5: Fitness for purpose of the system
SANS 1601	Structured wall pipes and fittings of unplasticized poly(vinyl chloride) (PVC-U) for buried drainage and sewerage systems
SANS 16422	Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure - Specifications
SANS 2001-DP1	Construction works Part DP1: Earthworks for buried pipelines and prefabricated culverts
SANS 2001-DP4	Construction works Part DP4: Sewers
SANS 21138-1	Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene criteria for pipes, fittings and system polyethylene (PE) Part 1: Material specifications and performance(PP)
SANS 21138-2	Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) Part 2: Pipes and fittings with smooth external surface, Type A

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COMMONLY USED STANDARDS FOR PLASTIC PIPING SYSTEMS	
SANS 21138-3	Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) Part 3: Pipes and fittings with non-smooth external surface, Type B
SANS 21307	Plastics pipes and fittings – butt fusion jointing procedures for polyethylene (PE) pipes and fittings
SANS 22391-1	Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT) Part 1: General
SANS 22391-2	Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT) Part 2: Pipes
SANS 22391-3	Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT) Part 3: Fittings
SANS 370	Steel mesh reinforced polyethelene (PE) pipes for water supply
SANS 4427-1	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 1: General
SANS 4427-2	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 2: Pipes
SANS 4427-3	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 3: Fittings
SANS 4427-5	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 5: Fitness for purpose of the system
SANS 4437-1	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) Part 1: General
SANS 4437-2	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) Part 2: Pipes
SANS 4437-3	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) Part 3: Fittings
SANS 4437-5	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) Part 5: Fitness for purpose of the system
SANS 674	Steel-reinforced spirally wound PE drainage and sewer pipes
SANS 791	Unplasticized poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings
SANS 8772	Plastics piping systems for non-pressure underground drainage and sewerage - Polyethelene (PE)
SANS 8773	Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene (PP)
SANS 966-1	Components of pressure pipe systems Part 1: Unplasticized poly(vinyl chloride) (PVC-U) pressure pipe systems
SANS 966-2	Components of pressure pipe systems Part 2: Modified poly(vinyl chloride)(PVC-M) pressure pipe systems

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COMMONLY USED STANDARDS FOR PLASTIC PIPING SYSTEMS	
SANS 967	Unplasticized poly(vinyl chloride) (PVC-U) soil, waste and vent pipes and pipe fittings
EN 13476-1 (Parts 1, 2 and 3) and ISO 9969	PE structured wall sewer pipes

STANDARDS RELEVANT TO THE MATERIAL AND RAW MATERIAL QUALITY FOR THERMOPLASTIC PLASTIC PIPING SYSTEMS	
SANS 1133	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
SANS 2505	Thermoplastics pipes - Longitudinal reversion - Test method and parameters
SANS 2507-1	Thermoplastics pipes and fittings - Vicat softening temperature Part 1: General test method
SANS 3127	Thermoplastics pipes - Determination of resistance to external blows - Round-the-clock method
SANS 9227	Corrosion tests in artificial atmospheres - Salt spray tests
SANS 9852	Unplasticized poly(vinyl chloride) (PVC-U) pipes - Dichloromethane resistance at specified temperature (DCMT) - Test method

STANDARDS FOR THE INSTALLATION PROCEDURES AND WELDING APPLICATIONS OF PLASTIC PIPING SYSTEMS	
SANS 10089-3	The petroleum industry Part 3: The installation, modification, and decommissioning of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations
SANS 10252-1	Water supply and drainage for buildings Part 1: Water supply installations for buildings
SANS 10252-2	Water supply and drainage for buildings Part 2: Drainage installations for buildings
SANS 10254	The installation, maintenance, replacement and repair of fixed electric storage water heating systems
SANS 10268-1	Welding of thermoplastics - Welding processes Part 1: Heated-tool welding
SANS 10268-2	Welding of thermoplastics - Welding processes Part 2: Electrofusion welding
SANS 10268-3	Welding of thermoplastics - Welding processes Part 3: Hot-gas welding
SANS 10268-4	Welding of thermoplastics - Welding processes Part 4: Hot-gas extrusion welding
SANS 10268-5	Welding of thermoplastics - Welding processes Part 5: Solvent welding
SANS 10268-6	Welding of thermoplastics - Welding processes Part 6: Ultrasonic welding, staking and insertion

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STANDARDS FOR THE INSTALLATION PROCEDURES AND WELDING APPLICATIONS OF PLASTIC PIPING SYSTEMS	
SANS 10268-10	Welding of thermoplastics - Welding processes Part 10: Weld defects
SANS 10269	Welding of thermoplastics - Testing and approval of welders
SANS 10270	Welding of thermoplastics - Approval of welding procedures and welds
SANS 1655	Welding of thermoplastics - Welding rods, fillers and solvents
SANS 1671-1	Welding of thermoplastics - Machines and equipment Part 1: Heated-tool welding
SANS 1671-2	Welding of thermoplastics: Machines and equipment Part 2: Electrofusion welding
SANS 1671-3	Welding of thermoplastics - Machines and equipment Part 3: Hot-gas welding
SANS 1671-4	Welding of thermoplastics - Machines and equipment Part 4: Hot-gas extrusion welding
SANS 1671-6	Welding of thermoplastics - Machines and equipment Part 6: Ultrasonic welding, staking and insertion
SANS 6269	Welding of thermoplastics - Test methods for welded joints

STANDARDS USED TO DETERMINE THE STRENGTH AND DIMENSIONAL REQUIREMENTS AND TOLERANCES FOR PLASTIC PIPING SYSTEMS	
SANS 130-1	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure Part 1: General method
SANS 9080	Plastics piping and ducting systems - Determination of the longterm hydrostatic strength of thermoplastics materials in pipe form by extrapolation
SANS 11922-1	Thermoplastics pipes for the conveyance of fluids - Dimensions and tolerances Part 1: Metric series

ADDITIONAL INTERNATIONAL STANDARDS FOR TESTING OF PLASTIC PIPING SYSTEMS	
ISO 6259-1	Thermoplastics pipes - Determination of tensile properties - Part 1: General test method
ISO 6259-2	Thermoplastics pipes - Determination of tensile properties - Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)
ISO 11357-6	Plastics - Differential scanning calorimetry (DSC) - Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)
ISO 13761	Plastics pipes and fittings - Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20 °C

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ADDITIONAL INTERNATIONAL STANDARDS FOR TESTING OF PLASTIC PIPING SYSTEMS	
ISO 18553	Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds
ISO 18553 Amd 1 2007	Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds (AMENDMENT 1)
ISO 21307	Plastics pipes and fittings - Butt fusion jointing procedures for polyethylene (PE) pipes and fittings used in the construction of gas and water distribution systems

PLTP 3 CERTIFICATION, DOCUMENTATION AND QUALIFICATIONS

All plastic pipes and fittings have to comply with the relevant SANS Specification and shall be certified accordingly by authorities accredited by SANAS (South African National Accreditation System), for example SABS and SATAS.

Pipe manufacturers have to be members of SAPPMA (South Africa Plastic Pipe Manufacturers Association).

The Contractor shall submit the following documentation of the manufacturers to the Engineer before commencement of the manufacturing of pipes and fittings:

- Proof of current SANS Standard certification for product.
- SANAS accreditation of the certification authority (e.g. SABS or SATAS).
- SAPPMA certificate in order to ensure adherence to the SAPPMA/IFPA code of conduct and quality assurance standards.
- ISO 9001:2015 quality control accreditation.

All pipes shall be marked with the date and time of production, relevant SANS Standard, mark of certification authority (e.g. SABS or SATAS), SAPPMA mark of quality reassurance, pipe diameter and pressure / strength class.

The following work must be performed by IFPA (Installation Fabrication Plastics Pipe Association) members:

- All fabricated fittings and specials manufactured from HDPE pipe or PVC pipe.
- All on site welding/gluing and fabrication work on Site.

IFPA members are bound by a code of conduct calling for full compliance to policies and local standards. IFPA members are able to prove full traceability to all its employees performing IFPA related tasks.

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The Contractor shall provide the necessary training to its employees to ensure IFPA standards are maintained. The Contractor shall submit its IFPA member certificate to the Engineer before commencement of manufacturing and construction.

PLTP 4 MATERIALS

PLTP 4.1 General

The following documentation shall be submitted by the Contractor to the Engineer before manufacturing:

- Certificate of Analysis (raw material)
- Quality Certificates (SABS, SATAS, etc.)
- Quality Control Plan

Inspection Documents shall comply with BS EN 10204 and shall be submitted by the Contractor to the Engineer. Unless otherwise specified in the Specifications or by the Engineer, Inspection Documents Type 3.1 are required.

Delivery of material shall only commence upon completion of the minimum required Batch Released Tests (BRT).

Quality systems shall be in accordance with SANS ISO 9001:2015 including Product Quality Plans for all products.

PLTP 4.2 PVC-O Pipes

PVC-O pipes shall be Class 500 with material properties as specified in paragraphs 4.1 and 4.2 of Technical Specification prCEN/TS 15223:2007(E) published by the European Committee for Standardization (CEN).

PLTP 4.3 High Density Polyethylene (HDPE) Pipes

Only unprocessed PE 100 polymer compliant to SANS ISO 4427-1 shall be used. This requirement shall be validated by the manufacturer.

PLTP 5 WELDING

Refer to PLTP 2 for the relevant welding standards.

The Contractor shall be responsible for the following:

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- Compiling of Preliminary Welding Procedure Specification, recording of qualification welds and conducting of 3rd party testing;
- Compiling of Welding Procedure Specification and Qualification Report with required testing;
- Compiling of Final Welding Procedure Specification;
- On-site 3rd party inspections;
- Compiling of Welding Quality Packs with inspection reports, COC's, COA's, Certificates, etc.

Employees responsible for electro-fusion or butt welding of HDPE pipes shall have (as a minimum) a certificate of competence at NQF Level 2 (in accordance to SANS 10268).

Welders shall be trained and qualified for a specific pipe diameter and class and for a specific welding process (e.g. butt, electro-fusion, socket fusion, hot gas extrusion) by Plastics SA. On successful completion of training the welder shall be tested and certified in accordance with SANS / ISO 10269 – Testing and approval of welders.

The IFPA stamp is required at all welds.

Calibration Certificates are required for welding equipment and welding machines shall be able to produce accurate welding reports.

PLTP 6 TESTING

PLTP 6.1 Hydrostatic pressure testing of spigot / socket joints

At least three spigot / socket joints per batch of uPVC pipes shall be subjected to the one hour test as described in Section 5.8 of SANS 966 Part 1 at a laboratory approved by the Engineer. The Engineer shall be provided the opportunity to witness these tests. Should any of the tests fail, the associated uPVC pipe batch will be rejected.

PLTP 6.2 Testing of HDPE butt-weld connections

Quality control testing during butt-welding of HDPE pipes will be required. In addition, the welder shall be separately qualified for all pipe sizes to be welded. The quality control testing for qualifying the welder shall be as follows:

- Observe the joining process to confirm that the proper butt-welding procedure is being followed.
- Visually inspect the joint and compare it to a sample or picture of an acceptable joint.
- Allow the joint to cool for at least one hour.

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- d) A 300 mm wide ring section of the HDPE pipe shall be cut with the butt-weld joint centered as illustrated in Figure 1. Cut four strips lengthwise through the joint area, 90 degrees apart for visual examination and bend testing. The width of the test bend is proportional to the pipe wall thickness. If the pipe wall thickness is less than 25.4 mm, a 25.4 mm wide strip is recommended. If the pipe wall thickness is greater than 25.4 mm, the width of the test strip shall be equal to the pipe wall thickness.
- e) Visually inspect the strap samples for voids, discontinuities, lack of bonding, misalignment, bead size, etc.
- f) The bend testing consists of the following steps:
- Allow each test strip to cool to a temperature ranging between 18°C and 27°C.
 - Each test strip shall then be clamped in a vice 25.4 mm under the weld bead as illustrated in Figure 2.
 - A steel extension pipe of appropriate diameter and length shall then be slipped over the free end of the specimen to 25.4 mm above the weld bead.
 - The bend test shall be performed by bending the test specimen 180 degrees (minimum 90 degrees) in the direction that places the concave interior surface/root of the pipe wall/weld in tension as illustrated in Figure 2. No failures in the butt-weld area are permitted with all four test strips.
- g) If flaws are observed or develop during bending, try to determine the cause, recheck the procedure, and make another joint.
- h) The welder is disqualified if the second joint is also unacceptable.
- i) Butt-weld of HDPE pipes to be installed shall not commence until a trial fission has passed the bend test.

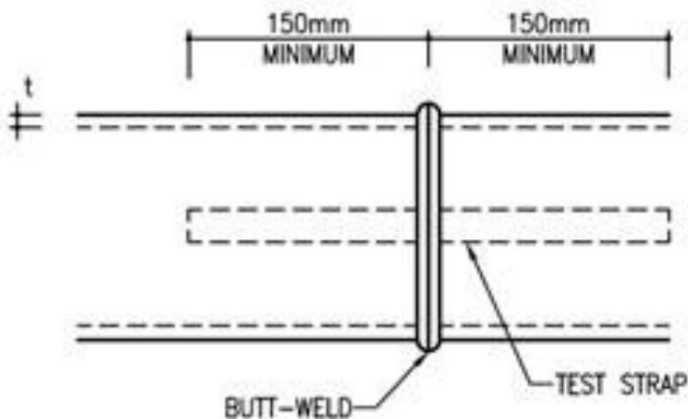


Figure 1: Bend strap test detail

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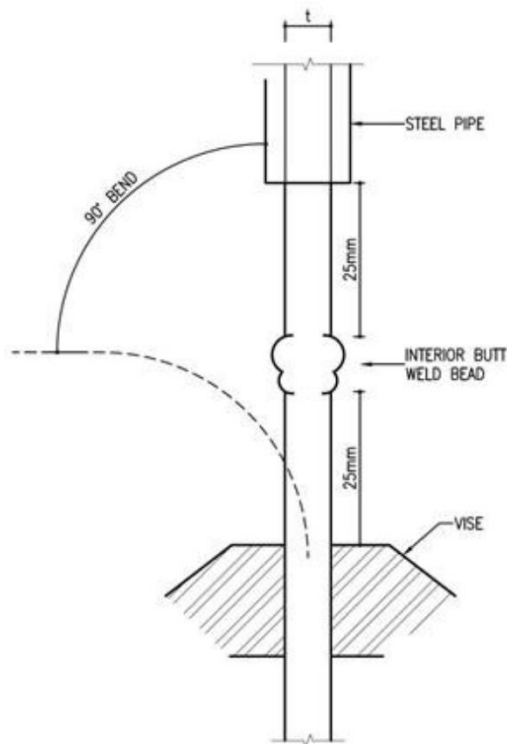


Figure 2: Bend strap test detail (side view)

PLTP 7 HANDLING AND INSTALLATION

PLTP 7.1 General

Handling and installation shall comply with guidelines provided in the Technical Manual of SAPPMA (latest edition).

PLTP 7.2 Ultra Violet (UV) protection

PVC pipes shall be stored under 80% black HDPE UV stabilised shade netting (blocking 80% UV).

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PLU: PIPE BORING

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PLU PIPE BORING

PLU1 SCOPE

This section covers the insertion by boring of underground pipes without disturbing the surface. The information regarding pipe jacking contained in this section is not limited to the jacking of circular precast concrete pipe sections but also applies in general to the jacking of rectangular, square and arched precast-concrete sections.

The Contractor shall make use of an approved specialist pipe jacking firm.

PLU2 INTERPRETATIONS

For the purposes of this section, the following words and expressions shall have the meanings hereby assigned to them except where inconsistent with the context.

- (a) Pilot hole
A hole with a maximum diameter of 50 mm, drilled to ensure that a subsequently bored, larger hole, will be properly aligned.
- (b) Pipe boring
The work involved in boring a horizontal hole and inserting a pipe therein. Also referred to as “directional drilling”.
- (c) Pipe boring pits
Excavations at either end of the boring operation from and between which boring and pipe installation are carried out.
- (d) Reception pit
An excavated shaft located at the end of a bored section of a pipeline.

PLU3 MATERIALS

- (a) Pipes – Pipe Boring
Pipes for pipe boring shall be HDPE Class SDR17 PN10.
- (b) Other precast-concrete sections
Any precast-concrete sections, other than pipes, to be bored shall comply with the requirements specified in the SABS 1200 or Section 3.4.2 of this document.

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PLU4 PLANT

(a) General

The Contractor shall, provide and use suitable equipment for boring the hole and for jointing and inserting the pipes.

(b) Lighting

The Contractor shall provide adequate lighting for the execution of the Works.

(c) Ventilation

Sufficient ventilation shall be provided to remove dust and to ensure safe working conditions.

PLU5 DESIGN

The Contractor shall furnish detailed design calculations, specifications and working drawings to explain his methods of installation and of providing temporary support for the road, rail track, or other service or structure and any modifications to structures required before pipe boring commences.

The design shall be carried out by a professional engineer with adequate experience in this field. Calculations, specifications and drawings shall be signed by the engineer responsible for their preparation.

PLU6 SAFETY

(a) General

The Contractor shall at all times observe adequate safety precautions on the Site as specified in Section 3.4.3 of this document. Permission to proceed with the Works shall not in any way detract from the obligations and liabilities of the Contractor in regard to such safety or to the adequacy of the boring structures and methods of working.

(b) Safety of existing works

The pipeline shall be bored through under the relevant road, railway or other service or structure without disrupting the traffic and without disturbing the alignment or levels of the road surface, the tracks, or other relevant service or structure to an extent that may impair the safety of traffic or of the service or structure.

Before commencing work in the vicinity of any structure, the Contractor shall make a detailed examination of the structure, record its condition, and submit a copy of such record to the Engineer.

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PLU7 SURVEYING

(a) General

The Contractor shall take measurements before and after each boring operation and shall record any change in line or level (or both) of any road, rail track or other service or structure being traversed. A copy of the records shall be submitted to the Engineer on the same day.

(b) Working under roadways

Before commencing work under a roadway, the Contractor shall measure levels on the road surface directly above the boring line and for a distance of at least 5 m on each side of the boring line. These levels shall be measured at 500 mm intervals and 300 mm from the edges of the surfacing. In order to facilitate control of the measuring of levels, the exact position of each spot height shall be discreetly marked on the road surface before the levels are measured.

After completion of the Works, the Contractor shall remeasure the levels in the same manner as before, and he shall submit to the Engineer the final records of levels taken before and after boring. The submission of such records shall be a prerequisite for any consideration by the Engineer of the acceptability or otherwise of the Works or the issue of any certificate of completion.

If, within the Defects Liability Period, the road shows any sign of settlement in the vicinity of the bored pipe, the road authority may remeasure the levels on the Site.

The Contractor shall be held responsible for the rectification, to the satisfaction of the road authority and the Engineer, of any deformation that occurs in the road surface as a result of the boring operation during the said period of one year.

(c) Checking the alignment of the pipeline

The Contractor shall check the line and the level of the pipeline at least once during the installation of each pipe length and shall take such corrective action as may be necessary. A copy of the results of all checks and a statement of any corrective measures taken shall be available for inspection on the Site, and a copy shall be given to the Engineer on the same day.

PLU8 BLASTING

No blasting will be allowed for pipe boring.

PLU9 CONSTRUCTION

(a) General

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Boring, excavation and other specialized work shall be undertaken only by persons fully conversant with the work.

Boring operations shall commence at the lower level of the pipeline. Should Site conditions necessitate or permit boring to be carried out from the higher level of the pipeline, the Engineer's written approval shall be obtained before the work commences.

The Contractor shall not commence any work until the Engineer has specified, in writing, that the Contractor may proceed.

(b) Excavation

Subject to the provisions of PLU8 above, the appropriate requirements of PSD and PSDB shall apply. The materials excavated shall be classified as follows for payment purposes:

(i) Hard material:

For pipe boring operations, the material penetrated will be classified as hard when the Contractor can prove that the work cannot be efficiently carried out by using normal boring equipment and some other method, such as rock drilling, has to be used.

(ii) Soft material:

All material not classified as hard material.

Notwithstanding the above classification, all material in previously constructed fills, embankments and pavement layers and through which boring is carried out, shall be classified as soft material.

The decision of the Engineer as to the classification of the material shall be final and binding, and any objection as to the classification shall be made before some method other than boring is used.

Special reference shall be made to clause 16 of section 001 regarding the classification of excavated material in restricted areas.

(c) Pipe boring pits

The Contractor shall be responsible for excavating the pits in the positions indicated on the construction drawings at each end of the section of pipeline or sleeve that is to be bored. These pits shall be of dimensions at least equal to the minimum dimensions needed for the Contractor's equipment and for safe and efficient working. The approximate dimensions of the pits that the Contractor intends to excavate shall be agreed upon with the Engineer before work commences. The excavated material shall be stockpiled for later backfilling.

The sides of the pits shall be adequately supported by timbers or by other approved means. Where a pit adjoins a railway line or a heavily used road, the sides of the pit shall be shored

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during the entire operation to prevent any movement caused by vibration arising from rail or road traffic from occurring.

The Contractor shall ensure that the pits are dewatered at all times.

(d) Pipe boring

After the pipe boring pits have been completed, and on the written instructions of the Engineer, a pilot hole shall be drilled using suitable equipment. After the pilot hole has been inspected and approved, it shall be enlarged by boring to the diameter required for the installation of the specified pipe.

(e) Grouting and sealing

Before the boring operation, the Contractor shall determine, in an approved manner, the average cross-section of the completed excavation ahead of the pipeline and shall submit his calculations to the Engineer on the same day.

These cross-sections, together with the external pipe diameter, shall be used for calculating the approximate volume of grout that will be needed after the entire boring operation has been completed and will assist in determining whether all voids have been grouted.

All holes in the pipeline shall be sealed with an approved epoxy sealant after the grouting has been completed.

The grouting of the pipes installed by means of pipe boring shall be carried out only on the written instructions of the Engineer and in a manner approved by the Engineer.

(f) Backfilling

The pipe boring pits shall be backfilled, only when so instructed by the Engineer, using excavated or imported material compacted to at least the density of the undisturbed surrounding material.

When the installed pipe is part of a pipeline, the boring pits will form part of the pipeline trench and as such shall be backfilled in the manner specified in sections SABS 1200D and DB as applicable. Payment for such backfilling will be made under the applicable sections.

Surplus excavated materials shall be disposed of as specified in the Project Specifications or as determined by the Engineer on Site.

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PLU10 TOLERANCES

Subject to any requirements of the Section 3.4.2 imposed on account of the gradient(s) of the pipeline or in view of the purpose for which it is required, the pipes shall be positioned within the tolerances given below.

Should the difference between the actual and the specified position or alignment of the finished pipeline exceed the value of the said tolerance to an extent as to involve additional costs in respect of locating, installing, supporting or maintaining any service of which the bored pipe forms part or that has been designed to be laid through the bored structure, the Contractor shall bear such additional costs, provided that the details of the work to be done to relocate, install, or support the said service have been provided and the order for the work to be done (by the Contractor or by others) has been given by the Engineer within 30 working days of the completion of the boring operation.

Permissible tolerance limits shall be as follows:

- (i) In plan ± 100 mm
- (ii) Vertical ± 100 mm

Adjustment to line or level or both shall be gradual, and the manufacturer's permissible angular deflection of the pipes shall not be exceeded at any point.

PLU11 MEASUREMENT AND PAYMENT

PLU11.1 Establishment on Site sum

The tendered lump sums shall include full compensation for the establishment on Site and the subsequent removal of all special equipment and plant for pipe boring, including maintaining the safety of existing structures, services, roads, railways, etc, for bracing, lighting, watching, dewatering and surveying, and for maintaining all temporary works until the work is completed.

This work will be paid for as a lump sum, 80% of which becomes payable when all equipment is on the Site and boring has commenced, and the remaining 20% will become payable after the work has been completed, the equipment removed and the Site reinstated to a condition acceptable to the Engineer.

PLU11.2 Access to and from pipe boring pits sum

The tendered lump sum shall include full compensation for the provision and maintenance of access roads to the reception pits, the negotiations with land owners where applicable, the erection and maintenance of temporary gates, fences and road signs where applicable, and for the removal and reinstatement of the access roads and temporary works on completion of the boring operations

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to the satisfaction of the Engineer and landowners concerned. The work will be paid for in two instalments as specified in pay item PLU10.1.

PLU11.3 Excavating in soft material cubic metre (m³)

The tendered lump sums shall include full compensation for all work necessary for excavating the pits to suit the Contractor's equipment, for excavating by hand where applicable, for shoring the sides of the excavation, and for stockpiling the excavated material at predetermined sites. The work shall be carried out as specified in the appropriate clauses of SABS 1200D and DB (see also PLU9 of this section).

PLU11.4 Extra over item PLU10.3 for excavating hard material cubic metre (m³)

The unit of measurement shall be the cubic metre of material measured in the original position before excavation and classified as hard in terms of sub-clause PLU9(b). The dimensions of the excavation shall be agreed on as specified in sub-clause PLU9(b) of this section.

The tendered rate shall include full compensation for all extra work and effort required for excavating in hard material.

PLU11.5 Backfilling the pipe boring pits with

The unit of measurement for shall be the cubic metre of suitable excavated or imported material used for backfilling the pipe boring pits to the extent determined by the Engineer.

The tendered rates shall include full compensation for loading approved material previously excavated or alternatively for loading the material from approved borrow pits, for transporting it to where required and for off-loading, and placing the material.

The tendered rate shall also include full compensation for compacting the material in 150 mm thick layers to a density of at least that of the surrounding undisturbed material.

Material shall be imported only on the instructions of the Engineer.

- | | |
|---------------------------|-------------------------------|
| (a) Excavated material | cubic metre (m ³) |
| (b) Imported material | cubic metre (m ³) |

PLU11.6 Supply of pipes to be bored (description, type and diameter stated) metre (m)

The unit of measurement shall be the metre of completed bored pipeline measured between the ends of the completed pipeline continuously through intermediate boring stations and shall include intermediate boring pipes.



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The tendered rate shall include full compensation for the supply, delivery and storing the pipes.
PLU11.7 Boring of holes through:

The unit of measurement shall be the metre length of hole bored and approved.

The tendered rates shall include full compensation for all labour, equipment (other than equipment provided under PLU10.1), materials and appurtenant work necessary to bore the hole including the pilot hole in the positions indicated and as specified and for removing any bored material to spoil sites found by the Contractor. Should spoil sites be provided by the Employer, overhaul will be payable where material is transported outside the free-haul boundaries.

- | | | |
|-----|--------------------------|-----------|
| (a) | Soft material | |
| (1) | Diameter of hole stated | metre (m) |
| (2) | Etc. for other diameters | metre (m) |
| (b) | Hard material | |
| (1) | Diameter of hole stated | metre (m) |
| (2) | Etc. for other diameters | metre (m) |

PLU11.8 Inserting pipes – Pipe Boring

The unit of measurement shall be the metre of each size and type of pipe jointed and inserted.

The tendered rates shall include full compensation for jointing and inserting the pipes in the bored hole.

- | | | |
|-----|--------------------------|-----------|
| (a) | State diameter of pipe | metre (m) |
| (b) | Etc. for other diameters | metre (m) |

PLU11.9 The grouting of voids for pipe boring

The unit of measurement shall be the metre of each size of pipe grouted on the instructions of the Engineer.

The tendered rates shall include full compensation for all plant, material and labour necessary for carrying out the work in a manner approved by the Engineer.

- | | | |
|-----|--------------------------|-----------|
| (a) | State diameter of pipe | metre (m) |
| (b) | Etc. for other diameters | metre (m) |

PLU11.10 Timbering and shoring left temporarily in the thrust and
reception pits and pipe boring pits square metre (m²)

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The tendered rate PLU10.3 shall include full compensation for the removal of the supply, fixing, timbering and shoring by the pipe-boring contractor.

END OF SECTION

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

PORTION 3: CONTRACT

PART C3.4: CONSTRUCTION

Section C3.4.4 Construction of Civil Works

Section C3.4.4.1 Standard Specifications

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RUSTENBURG WATER SERVICES TRUST

BID No RLM/RWST/OMM/0103/2024/25

**RE-ADVERT: UPGRADE AND EXTENSION OF BOSPOORT WATER
TREATMENT WORKS – MECHANICAL AND ELECTRICAL WORKS**

C3.4.4 CONSTRUCTION OF CIVIL WORKS

C3.4.4.1 STANDARD SPECIFICATIONS

The applicable “Standard Specifications” shall be the document “Standard Specifications for Civil Engineering Construction, SABS 1200-1986”, issued by the South African Bureau of Standards.

Note 1 The Standard Specifications are not bound into the tender and contract documents but are available at the Tenderer’s/Contractor’s expense from the South African Bureau of Standards in Pretoria, Private Bag X191, PRETORIA, 0001.

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