

**MOKOLO AND CROCODILE  
WATER AUGMENTATION PROJECT  
PHASE 2 (MCWAP-2)**

**TENDER NO 054/2024/PMID/MCWAP2/RFB**

**PART C3.1  
SPECIFICATION**

**SECTION 38**

**ELECTRICAL GENERAL**

## PART C3.1 SPECIFICATION

### SECTION 38 ELECTRICAL GENERAL

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## SECTION 38

### ELECTRICAL GENERAL

#### 38.1 SCOPE

This Section covers the design, supply, delivery, installation, testing and commissioning of the electrical system of Phase 2 of the Mokolo Crocodile Water Augmentation Project (MCWAP-2). This shall be interpreted as the Employer's requirements with regard to the system design obligations.

This Section shall be read in conjunction with Section 39 - Electrical Plant and Installation and the remainder of the Contract and in particular with Sections 39 – Electrical Plant and Installation, Sections 37 – Painting and Corrosion Protection and Section 48 – Tests on Completion. In the event of conflict, this Section shall take preference over Section 39 – Electrical Plant and Installation.

Section 38 shall also be read in conjunction with the Technical Schedules contained in Part T2.2.2 of the Contract. Any deviation from the agreed Technical Schedules shall be approved by the Engineer. Any application for a concession or replacement shall be accompanied by a revised Technical Schedule.

For integration purposes the complete scope of the Electrical Works on the Project is indicated here. The BoQ is structured to indicate the different Parts of the Works. The scope of work includes the electrical installation at:

- a) Abstraction Works including the Diversion Weir, Boulder Trap, Gravel Trap and Sand Traps;
- b) Low-Lift Pumping Station at the Diversion Weir;
- c) Balancing Reservoir at the High-Lift Pumping Station;
- d) High-Lift Pumping Station;
- e) Operation and Control Centre (O&CC), guardhouses and instrumentation huts;
- f) Break Pressure Reservoir;
- g) Cathodic protection installations; and
- h) Control and communication network installations.

Electrical reticulation will be provided to:

- a) Pumps;
- b) Cranes;
- c) Large diameter valve actuators;
- d) Hydraulic operated gates;
- e) Lighting and small power of the Abstraction Works, Pumping Stations and ancillary buildings;
- f) Operation and Control Centre (O&CC);
- g) Security installations;
- h) Emergency and area lighting;
- i) Transformer rectifier units along the pipeline route; and
- j) Instrumentation and communication installations; and Control and communication network plant.

This Contract includes the design, supply, delivery, installation, testing and commissioning of the following:

- a) Medium voltage switchgear;
- b) Medium voltage underground cabling;
- c) Distribution transformers;
- d) Low voltage cabling;
- e) Low voltage switchboards and motor control centres (MCCs);
- f) Standby generators;
- g) Uninterruptible power supplies (UPSs);
- h) Battery and battery chargers;
- i) Medium voltage variable speed drives (VSD's);
- j) Medium voltage power factor correction;
- k) Motor surge protection;
- l) Earthing and lightning protection;
- m) Fire and smoke detection and prevention;
- n) Lighting and small power; and
- o) Any other installation and materials stated or implied to provide for a complete installation in accordance with the Specification, Drawings and Schedules supplied.

## **38.2 DEFINITIONS AND REFERENCES**

### **38.2.1 Definitions**

In this Section the word or words:

- a) **“Design”** includes, as applicable, the submission of electrical design documentation to obtain approval from the Engineer.
- b) **“Supply”** includes, as applicable, the purchase of materials or goods, manufacture and fabrication, any specified corrosion protection measures and any off-site inspection or testing.
- c) **“Installation”** includes, as applicable, all handling and transport from storage, if necessary, all erection and setting to work.
- d) **“Factory Acceptance Test (FAT)”** shall refer to all tests done on Plant or Plant items at the factory to ensure its functionality.
- e) **“Pre-commissioning”** shall refer to the functional field test done on specific part of Plant on Site. This forms part of Tests on Completion as specified in Section 48.

### **38.2.2 References**

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

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**38.3 INSTALLATIONS BY OTHERS**

The following will be provided by others concurrently with this Contract:

- a) 2 x 20 MVA 132/11 kV outdoor substation (Eskom); and
- b) Various Eskom connection points along the high-lift rising and gravity main pipeline routes.

**38.4 BATTERY LIMITS**

The battery limits between Employer's Design and Contractors Design is shown on the Drawings. The Contractor shall design the complete VSD, Power Factor Correction installation, Surge Protection, Motor and Pump installation, including control and cabling to ensure compatibility and correct sizing of Plant.

The battery limit of the power installation is the terminals of the Eskom substation 11 kV switchboard.

Cable type and sizes for Contractor design responsibility are included in the Bill of Quantities for Tender purposes only. The Contractor shall submit a detail cable schedule for approval before ordering any cable.

The Contractor shall take note of the minimum fault level at Eskom terminals and required start up time of the pumps to size motors to drive pumps. Details of all calculations, load flow studies and start up curves shall be submitted at Tender stage.

Any alternative design offered at Tender stage shall be backed by calculations and load flow studies.

Low Voltage power supply to the Break Pressure Reservoir, Cathodic Protection, Instrumentation Huts along the pipeline route and Points of Supply will be arranged by TCTA. However, this Contract need to consolidate the Eskom Distribution account information during the preparation of the Operation and Maintenance Manuals.

**38.5 GENERAL INFORMATION**

Not used. The heading is retained for consistency of the Clause numbering.

**38.6 STANDARDS AND REGULATIONS**

All materials and Plant shall be new and of the standard and quality specified.

The Contractor shall ensure that he is fully acquainted with the contents of Section 39 – Electrical Plant and Installation of the Specification.

The design and manufacture of Electrical Plant and the complete installation shall be carried out and tested in accordance with the latest issue or amendments of the following Regulations, as applicable:

- a) SANS 10142 – The Code of Practice for wiring of premises as amended;
- b) The Occupational, Health and Safety Act, (Act 85 of 1993 and its regulations);
- c) The local municipal by-laws and regulations and regulations of the local supply authority;
- d) The Fire Brigade Services Act, 2000 (Act 14 of 2000);

- e) The Regulations of Telkom (S.A) Ltd;
- f) The National Building Regulations and Building Standards Act, (Act 29 of 1996); and
- g) The Electricity Act, (Act 88 of 1996).

### **38.7 ENVIRONMENTAL AND SITE CONDITIONS**

The following information pertains to the Site and Works:

- |  |   |
|--|---|
| a) Altitude above sea level:             | Vary between 894 and 1117 m.a.s.l.  |
| b) Maximum recorded ambient temperature: | 40.7 °C.  |
| c) Nominal MV supply:                    | 11 kV; 3 phase; 3 wire.   |
| d) Nominal LV supply:                    | 400 V; 3 phase; 4 wire with earthed neutral.  |
| e) Nominal supply frequency:             | 50 Hz.  |
| f) Fault level:                          | Refer to Single Line Diagrams and to Clause 38.10 below for bulk medium voltage supply. |

The Contractor shall determine if the Plant items supplied under this Contract will fit into the spaces provided for the Plant, prior to ordering.

Lightning protection shall be provided on all 400 V distribution boards to generally limit the impulse level to 1 kV.

No other special allowances for short- or long-term over- or under voltages, impulses, transients, spikes, surges, mains borne interferences or power failures will be provided. The Contractor shall ensure that all Plant, electrical or electronic, will be suitable for continuous, reliable operation under these circumstances, and the Contractor shall ensure that all Plant is adequately protected in this regard, whether such protection has been specified in detail or not.

Failure or malfunction of any component of the installation attributable to any form of transients or power surges shall be rectified at the Contractors expense.

### **38.8 MAIN SERVICES**

The Contractor shall familiarise himself with the positions of the other main services, i.e. pipelines, water pipes, stormwater sleeves and sewer pipes and co-ordinate these services to ensure an unobstructed path for any cable installations.

Should obstructions be identified these must be brought to the attention of the Engineer as soon as possible.

### **38.9 MATERIALS**

All indoor switchboards, distribution boards and control panels shall be mild steel painted in accordance with paint system number 402 in Section 37 – Painting and Corrosion Protection.

All outdoor switchboards, distribution boards and control panels shall be 3CR12 painted in accordance with paint system number 414 in Section 37 – Painting and Corrosion Protection.



All cable trays, conduit and cable ladders shall be hot dip galvanized in accordance with paint system 453 in Section 37 – Painting and Corrosion Protection.

All fixing bolts, nuts, washers, brackets, etc., shall be stainless steel.

In addition to normal operating loads, all Plant shall be designed and installed to withstand without damage a seismic acceleration of 0.1 g.

All Plant and material to be corrosion protected shall be protected in accordance with the corrosion protection systems specified in Section 37 – Painting and Corrosion Protection. Should a corrosion protection system not be clearly defined, the Contractor shall agree the appropriate system with the Engineer prior to ordering the product.

Cables shall be flame retardant, low toxic cable type (blue stripe). Fire barriers shall be provided at every point where cables cross walls. Pratley type Enviro glands shall be used for all cable terminations.

### **38.10 POWER SUPPLY**

#### **38.10.1 General**

All Medium Voltage switchgear shall be in accordance with the Section 39 – Electrical – Plant and Installation of the Specification.

Standby power through a standby diesel generator system shall only be provided for the:

- a) High-Lift Pumping Station (HLPS);
- b) Low-Lift Pumping Station (LLPS);
- c) Operation and Control Centre (O&CC); and
- d) Guardhouses inside the National Key Point (NKP) areas.

All control and instrumentation power supplies shall be from uninterruptible power supply (UPS) installations to be supplied in this Contract.

#### **38.10.2 Eskom Supply**

A dual 11 kV medium voltage power supply will be provided at the HLPS from a 2 x 20 MVA 132/11 kV Eskom substation (20 MVA firm).

The Contractor shall be responsible for the following:

- a) Install all power cables and terminate at both ends from the Eskom substation 11 kV switchboard to the new HLPS 11 kV switchboard;
- b) Install all the supply, control and protection cables and lines including terminations and testing; and
- c) Ensure correct CT ratio and settings from Eskom for cable differential protection, including commissioning.

### **38.10.3 Proposed Low-Lift Pumping Station (LLPS)**

Power will be supplied to the LLPS from the HLPS through 2 x 11 kV underground cables.

Medium voltage (11 kV) power supply will be controlled and distributed by double bus-bar indoor metal clad switchgear to the Plant. The Contractor appointed shall be responsible for the entire electrical, protection and control Plant as per the single line diagrams. This includes cables, transformers, switchgear, PFC, AC and DC system, protection and control, automation, standby generator, LV distribution and any other requirement as specified in the Tender document and bill of quantities.

Site metering at the LLPS will be done on the 11 kV indoor circuit breakers. The Contractor shall allow for VTs and CTs as shown on the Drawings and as specified.

### **38.10.4 Proposed High-Lift Pumping Station (HLPS)**

Medium voltage (11 kV) power supply will be controlled and distributed by double bus-bar indoor metal clad switchgear to the Plant. The Contractor appointed shall be responsible for entire electrical, protection and control Plant as per the single line diagrams. This includes cables, transformers, switchgear, PFC, AC and DC system, protection and control, automation, standby generator, LV distribution and any other requirement as specified in the Contract document and Bill of Quantities.

Site metering at the HLPS will be done on the 11 kV indoor circuit breakers. The Contractor shall allow for VTs and CTs as shown on the Drawings and as specified.

#### **38.10.4.1 Network Capability Values at High-Lift Pumping Station**

As received from Eskom, the fault levels at the Eskom substation are:

- a) Maximum 1  $\Phi$  - Fault Level (132 kV) 6.42 kA.
- b) Maximum 3  $\Phi$  - Fault Level (132 kV) 6.82 kA.
- c) Maximum 1  $\Phi$  - Fault Level (11 kV) 2.17 kA.
- d) Maximum 3  $\Phi$  - Fault Level (11 kV) 16.58 kA.

### **38.11 MEDIUM VOLTAGE SWITCHGEAR**

Refer to Section 39 – Electrical – Plant and Installation.

The 11 kV medium voltage switchgear shall be complete with protection relays as shown on the Drawings.

Mechanical interlocking shall be provided as shown on the Drawings. All bus-couplers and bus-sections would normally be operated in the open position.

Metering CTs and VTs shall be installed as indicated.

All incomers shall be provided with ammeters (1 off per panel wired to white phase) and voltmeters (1 off per panel wired to white phase). If the protection relays offered are unable to provide per phase current and voltage indication, provision for selector switches must be made.

All MV switchgear shall be in accordance with the relevant parts of:

- a) SANS IEC 62271, SANS IEC 62271-100 and 200 :2011, HV metal enclosed switchgear;
- b) SANS 60694, Common specifications for HV switchgear;
- c) SANS 60044-1, Current transformers;
- d) SANS 60044-2, Voltage transformers;
- e) SANS 62271, AC metal enclosed switchgear; and
- f) NRS 003, Metal clad switchgear for AC above 1 kV.

All MV switchgear shall be constructed with metal-clad enclosures, and either utilise vacuum or Sulphur hexafluoride (SF6) technology. A fixed pattern / horizontal / vertical isolation draw-out truck type arrangement shall be provided.

The 11 kV switchgear shall have an internal arc classification IAC AFLR for withdrawable switchgear and IAC AFR for fixed pattern switchgear and be tested according to IEC 62271-200, with the following additional requirements:

- a) All power compartments shall be tested i.e. busbar compartment, circuit breaker compartment, cable compartment and current transformer compartment.
- b) Tests shall be carried out according to Type A, i.e. 'Metal-enclosed switchgear and control gear with accessibility restricted to authorised personnel only.
- c) Test voltage, current and duration for 12 kV panels shall be at least 12 kV/25 kA for 200 ms.

### **38.12 DISTRIBUTION TRANSFORMERS**

Refer to Section 39 – Electrical – Plant and Installation.

Distribution transformers shall be of the 25 kVA, or 50 kVA, or 100 kVA 11 000/420-230 V, oiled-immersed, ground mounted, sealed units with fully enclosed cable termination boxes, as indicated on the Drawings.

The vector group shall be Dyn11.

The distribution transformers shall be installed in locations as indicated on the Drawings.

### **38.13 LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES (MCC)**

Refer to Section 39 – Electrical – Plant and Installation.

Switchboards and MCCs shall be installed in the rooms as shown on the Drawings.

PLC Plant and terminations shall be housed in a separate panel.

The terminations shall be sufficient to host all I/Os for the PLC cards plus 20% spare capacity. The panels shall be complete with PLC power supply Plant as shown on the Drawings.

The busbars shall be positioned in such a way to allow for easy extension to the sides by adding additional panels, and to allow for cable entry from the bottom and top. Their spacing shall be in such a way that the cables could be connected to them in a neat and safe configuration. The busbars shall be rated for the full load capacity of the main switch and shall be capable of withstanding the fault level as indicated on the Drawings for 3 seconds.

All Plant shall be rated for the fault levels indicated on their respective busbars. Where fault level values are not shown, a minimum of 5 kA symmetrical rupturing capacity at 400 V 50 Hz shall be accomplished.

Push buttons shall be of the round type. The function of the push buttons shall be engraved on the buttons.

Indicating lights shall be of the same manufacture as the push buttons and shall be of the LED cluster type. They shall be provided with a lamp test push button to verify operation.

All control terminals shall be of the rail mounted type and shall be fitted with terminal numbers.

Surge arrestors shall be complete with failure indication facility. These units shall be installed on all phases plus neutral and shall be as accessible as circuit breakers. Surge arrestors shall be solidly earthed by means of 16 mm<sup>2</sup> insulated earth wires.

A local control panel shall be supplied and installed at each pump set as specified. The control panel shall be a 1.2 m high floor standing panel, equipped with a touch panel and any other field control devices required for the pump set. The bottom part of the control panel shall also be used as a marshalling cubicle for all fields I/O on that pump set.

Earth leakage protection shall be provided for LV motors as follows:

- a) Earth leakage protection shall be provided for each outgoing circuit and shall be implemented either by means of a unit mounted integrally with the associated circuit breaker or by means of a separate earth leakage relay. **Separate earth leakage relays shall be used unless integral earth leakage is specifically called for, or intelligent relays, incorporating an earth leakage facility are used.**
- b) Unless expressly waived by the Electrical Engineer, integral earth leakage units shall operate on the electromechanical polarised release principle. It shall be impossible to disable the earth leakage module short of physically dismantling it from the breaker. The earth leakage module shall be provided with a test button, neither of which is to be accessible when the cubicle door is closed. Specific indication of an earth leakage trip shall be provided on the MCCB. **Integral earth leakage shall be provided only for drives up to and including 75 kW<sub>1</sub>** and shall operate instantaneously for faults of 250 mA and above.
- c) Where separate earth leakage relays are specified, they shall have visible flag trip indication, a test / reset button, and one normally open and one normally closed output contact. Each earth leakage relay shall be wired to shunt trip the power MCCB in its respective circuit, and shall be door-mounted.

Earth leakage relays are to be as follows:

- 0 to 75 kW – 250 mA instantaneous EPC type E1-Sec-X and Transcore X; and
- 90 kW up – 375 mA EPC AEL-Sec-T Curve 1 and Transcore T.

### 38.14 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

Refer to Section 39 – Electrical – Plant and Installation.

The UPS phase in / phase out configuration shall be as specified on the Drawings and will be used for instrument power supply, PLC power supply and control.

UPS ratings, shall be at least as shown on the Drawings. The Contractor shall confirm the power consumption estimates submitted at Tender stage prior to ordering any units.

The following potential free alarm outputs are required, for connection to a PLC:

- UPS healthy; and
- Load on bypass.

### **38.15 BATTERIES AND BATTERY CHARGERS**

Refer to Section 39 – Electrical – Plant and Installation.

A dual DC system complete with charging- and battery units are required.

A DC power supply is required with a nominal voltage of 110 V, with capacity to supply the base load of SCADA and protection relays for 24 hours. Calculations for the sizing of the power supply must accompany the Tender and the power drawn by the proposed circuit breaker must be included in the schedules. The ampere hour rating of batteries shall be adequate to trip and close all circuit breakers five times. It shall also be capable to carry the full load of the protection and control circuits of the substation for at least 24 hours.

The battery charger must be supplied from an AC distribution board. The charger must be capable of charging, fully discharged batteries to 80% of nominal voltage within six hours while supplying the station load.

The charger must have the following features:

- a) Alarm indication when voltage is less than 90% of nominal voltage via two sets of potential free contacts;
- b) Alarm indications in the event of AC supply failure via two sets of potential free contacts;
- c) A sufficiently scaled ammeter with a midpoint zero indicating the charge / discharge current. The ammeter shall be of the moving coil type. The range shall be sufficient to indicate maximum currents in both modes;
- d) A warning light with alarm which indicates a battery earth fault; and
- e) Volt meter indicating the battery voltage.

Boost charge facility that will reset automatically after to normal float charge after predetermined time which must be adjustable.

### **38.16 DIESEL STANDBY GENERATOR**

Refer to Section 39 – Electrical – Plant and Installation.

Diesel standby generators shall be installed in weatherproof enclosures, provided in the locations as indicated on the Drawings. Diesel standby generators shall be installed at the HLPS, LLPS, O&CC and guardhouses located inside the NKP areas. The generator size, as shown on the Drawings, is an approximate size. The Contractor shall confirm the size of the generators in accordance with load information provided on the single line diagrams.

The generator shall be equipped, complete with a diesel day tank, as specified in the Specifications sufficient for 1 day of fuel supply.

Automatic change over Plant and the main switchboard shall be provided, inside the LV room, as shown on the Drawings.

Final colour of Plant and pipework to be agreed with the Engineer.

All the PLC I/Os as shown on the Drawings and as specified in the Specifications shall be wired to terminations provided inside the generator control panel.

The following additional common alarms shall be wired to the terminations:

- Low fuel alarm;
- Generator failed to start;
- Generator faulty; and
- Electrical trip.

### **38.17 LOW VOLTAGE INDUCTION MOTORS**

Refer to Section 39 – Electrical – Plant and Installation.

Low voltage motors shall be as specified in Section 39 – Electrical – Plant and Installation. The motors shall be supplied as part of the mechanical Plant and shall be sized by the Contractor.

Only high efficiency motors with efficiency higher than 95% shall be acceptable.

### **38.18 MEDIUM VOLTAGE INDUCTION MOTORS**

Refer to Section 39 – Electrical – Plant and Installation.

Medium voltage motors shall be as specified in the Standard Specification. The motors shall be supplied as part of the mechanical Plant and shall be sized by the Contractor.

Only high efficiency motors with efficiency higher than 95% shall be acceptable.

The Contractor shall provide torque and load curves for the pump, motor and drive combinations, at Tender stage, to prove successful starting and stopping of pump sets. The starting current shall not exceed 7 times the full load current.

Motors shall be water-cooled and shall be connected to the water-cooling network as shown on the Drawings.

Motors shall be supplied complete with surge protection (Zorc) as required.

Motors shall be provided with temperature and vibration sensors as specified and shown on the Drawings and shall be wired to a termination box on the motor.

Motor heaters shall be provided and wired to a termination box on the motor.

### **38.19 MEDIUM VOLTAGE VARIABLE SPEED DRIVES (VSD)**

Refer to Section 39 – Electrical – Plant and Installation.

Medium voltage VSD's shall be provided for at the HLPS and LLPS respectively as shown on the Drawings.

VSD's shall be supplied complete with their own internal phase-shifting transformer to step the input supply voltage down from 11 kV to either 6.6 kV, to supply the motor voltage at the HLPS, or 3.3 kV to supply the motor voltage at the LLPS.

The VSD shall be complete with all protection, contactors and all other Plant specified in Section 39 – Electrical – Plant and Installation.

The VSD shall provide soft starting and soft stopping and shall conform to the apportionment values, supplied by Eskom.

The pump shall be started against an open valve with a linear acceleration curve. Start-up time shall be at least 60 seconds to allow for pipe surges. The VSD, pump motor and pump combination shall be correctly sized to allow for the acceleration curve and to prevent overheating of Plant.

The Contractor shall review the method statement submitted with the Tender, indicating motor start up philosophy, motor current / speed curves, motor torque / speed curves, load torque / speed curves, calculated load inertia and calculated start up time.

Power Factor Correction capacitors shall be installed with the VSD. The Contractor shall indicate connection detail and control.

Zorc type, or equivalent, surge protection shall be provided. The Contractor shall provide surge arrestor detail, connection detail and control.

Motor heaters shall be switched from the VSD in the off position. Details and external power requirements shall be reviewed and approved by the Contractor's designer.

The Contractor shall confirm the cable type required between the VSD and motor and the maximum length of cable allowed prior to ordering the VSD.

Each pump set shall have a dedicated PLC and a touch panel which is mounted on a control panel. All external trip signals, as shown on the Drawings, shall be wired directly to the VSD. The VSD shall be connected to the PLC, touch panel and other drives via a suitable network.

The motor, pump and VSD combination shall be factory tested at various loads to prove efficiency and compatibility. The Engineer shall witness the test.

The High-Lift Pumping Station power supply is from the adjacent Eskom substation. The Contractor shall calculate anticipated, worst case, harmonics, unbalance, flicker and rapid voltage change values for the Pumping Station and confirm the values.

### **38.20 FIRE DETECTION AND GAS SUPPRESSION PROTECTION**

Refer to Section 39 – Electrical – Plant and Installation.

Fire detection and gas suppression protection shall be provided for the following Pumping Station rooms and areas:

- a) High-Lift Pumping Station
  - i) Detection Areas:
    - Pump Station Plant Room (Basement);
    - Battery Room;

- 
- UPS Room;
  - MV Room;
  - LV and MCC Room;
  - VSD Room;
  - HVAC Plant Room;
  - Control Room;
  - Store Room;
  - Building Perimeter (Aspirating Reference Sampling System);
  - Guard house; and
  - Pumping Station Main Passage.
- ii) Gas Suppression Areas:
- Battery Room;
  - UPS Room;
  - MV Room;
  - LV and MCC Room; and
  - VSD Room.
- b) Low-Lift Pumping Station:
- i) Detection Areas:
- Pumping Station Plant Room (Basement);
  - MV and Battery Room;
  - LV and MCC Room;
  - VSD Room;
  - HVAC Plant Room;
  - Control Room;
  - Pumping Station Main Passage; and
  - Building Perimeter (Aspirating Reference Sampling System).
- ii) Gas Suppression Areas:
- MV and Battery Room;
  - LV and MCC Room; and
  - VSD Room.

Fire detection signals shall be transmitted to a main addressable fire detection control panel located in the Control Rooms of the LLPS, HLPS and O&CC. All required fire detail control panels signals shall be connected from a communications card, located in the panels, to the SCADA system.



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**Fire Detection Alarm Signal Schedule:**

- a) Aspirating Detectors:
  - Alert;
  - Fire 1;
  - Fire 2; and
  - Fault.
- b) Gas Release Control Panels:
  - Fault;
  - Fire;
  - Auto / Manual Switching;
  - Gas Discharge; and
  - Actuator Open Circuit / Fault.
- c) Main Addressable Fire Detection Control Panel:
  - Fault; and
  - Fire.

The Contractor shall be responsible for the design and installation of the complete fire detection and gas suppression protection installation. Drawings and detail of Plant shall be submitted to the Engineer for approval.

**38.21 PROTECTION RELAYS AND SCHEMES**

Refer to Section 39 – Electrical – Plant and Installation.

Drawings and detail of Substation protection system, relay settings and coordination curves shall be submitted to the Engineer for approval.

**38.22 PUMPING STATION EARTHING**

Refer to Section 39 – Electrical – Plant and Installation.

The Contractor shall be responsible for resistivity measurements on site and the complete design of the earth mat.

Drawings and detail of Plant shall be submitted to the Engineer for approval.

**38.23 POWER FACTOR CORRECTION**

Refer to Section 39 – Electrical – Plant and Installation.

Suitable power factor correction shall be provided for the VSD's in the Pumping Stations. Each VSD shall have an individual capacitor bank mounted in the same room as the VSD's.

The power factor correction Plant shall be connected to VSD's as recommended by suppliers of Plant, as offered by the Contractor. The Contractor shall make provision for any additional contactors as required by the Plant offered.

Suitable discharge circuits and surge arrestors shall be provided to protect the motor against any spikes caused during switching.

The Contractor shall provide information on the complete installation during Tender stage and the anticipated rectified power factor correction for the complete installation during various load conditions.

#### **38.24 CABLEING**

Refer to Section 39 – Electrical – Plant and Installation.

Cable sizes, types and approximate lengths are as shown on the Drawings. Installation shall be done in accordance with the standard installation Specification.

Cables shall be flame retardant, low toxic cable type (blue stripe). Fire barriers shall be provided at every point where cables cross walls. Pratley type Enviro glands shall be used for all cable terminations.

#### **38.25 PUSHBUTTON CONTROL STATIONS**

Control stations shall be double insulated, complete with two spring return pushbuttons as required. The stations shall comply with I.E.C. 947-S-1 and suitable for operations to 70°C. They shall have a protection rating of IP65.

Emergency stop pushbuttons shall be provided at the pump motor as well as on the control panel associated with the pump set.

#### **38.26 EARTHING AND LIGHTNING PROTECTION**

Refer to Section 39 – Electrical – Plant and Installation.

Lightning protection of buildings and structures will be done as part of the building installations.

The Contractor shall be responsible for all electrical and instrumentation earthing as specified and as shown on the Drawings.

#### **38.27 LIGHTING AND SMALL POWER**

Refer to Section 39 – Electrical – Plant and Installation.

The Contractor shall be responsible for the complete lighting and small power installation in all the Pumping Stations and outstation buildings. The complete installation shall be surface mounted, unless otherwise stated on the Drawings.

The lighting installation shall be as indicated on the Drawings. Fittings offered by the Contractor shall be as indicated on the Drawings or Data Sheets.

Luminaires shall be supplied and installed complete with lamps, ballast's, electronic control gear, diffusers, mounting facilities, etc., as applicable. All fittings shall be new and unused and shall be delivered to site as packed by the supplier. Fixing and fitting of luminaires shall not compromise the protection rating of the luminaire, junction boxes and cables.

All lamps and control gear shall be rated for the supply voltage of 220 V-240 V as specified.

The permanent luminaires intended for installation shall not be used for temporary lighting during construction. The Certificate of Completion for the installation will not be finalised unless all light fittings and lamps are in working order.

The operating circuits of discharge type fittings shall be provided with suitable power factor compensation, ensuring a power factor better than 0.9.

All access holes shall be sealed off with compression glands and other suitable covers to ensure a weatherproof installation, as required.

The luminaires that are equipped with emergency back-up control gear shall be wired with a normal supply as well as an unswitched supply, to ensure that the batteries remain fully charged at all times.

The weatherproof, 3 phase switched socket outlets shall be non-corrosive, IP57, and shall be installed on the surface. Cabling shall be surface mounted.

Three phase, 4-pole, 400 V, 50 Hz welding and power outlets shall comply with SANS 1239, and shall be installed at appropriate locations for supplying power to portable welders and similar loads. Sufficient circuits and number of outlets shall be provided in order that all areas of the building can be reached with a 30 m extension cord. Cognizance shall be taken of Company standardisation when specifying welding sockets and plugs. Outlets shall generally be mounted 1400 mm above the floor. Individual sockets shall be equipped with an internal, 30 mA earth leakage protection device as required by SANS 10142.

### **38.28 LABELLING AND NUMBERING**

Plant shall be marked clearly in accordance with the Drawings.

Plant not designated or numbered on the layout Drawings shall be labelled by means of a unique numbering system for ease of identification. The Contractor shall apply the numbering system as prescribed by the Engineer.

All cables shall be clearly labelled at both ends. Each end shall be labelled to identify the Plant it is connected to on its other end. More than one cable of the same type shall be distinguished by a second suffix in numerical order.

Circuit as well as cable numbers shall appear on all "as-built" ("as installed") drawings.

Draw boxes and terminals shall be numbered and labelled.

Labels shall be permanent and indelible.

Numbering and labelling shall be such that, during maintenance, the wiring can be traced by using the "as-built" ("as installed") drawings.

**38.29 OPERATION AND MAINTENANCE MANUALS**

Submission of O&M Manuals shall be as required under Section 48 - Test on Completion.

**38.30 TOOLS AND ACCESSORIES**

All tools, special tools and accessories required for the normal operation and maintenance of all the Plant and systems supplied, shall be included in this Contract.

All keys, tools and special tools shall be in duplicate and handed to the Engineer upon completion. The Contract shall be deemed to be incomplete until this requirement has been met.

The Contractor shall ensure that all tools and equipment required are available during inspections and testing. This includes two-way radios, meters, keys, manhole cover removers, conductivity meters, bridging pieces, recorders and personnel as required.

**38.31 TESTS AND TESTS ON COMPLETION**

Factory Acceptance Testing, Site Testing and Tests on Completion shall be as per Section 48 - Test on Completion and Section 39 – Electrical – Plant and Installation.

**38.32 MAINTENANCE AND GUARANTEE**

The Plant and installation included in this Contract shall be guaranteed and maintained in all respects for the duration of the Defects Notification Period.

The Contractor shall, for the full duration of the Defects Notification Period, be responsible for all work and Plant replacements required, including labour, travelling costs, the replacement of lamps and fuses, etc. Renewals or repairs resulting from misuse, however, will not be made at the expense of the Contractor. The Contractor shall repair / replace faulty Plant within 48 hours of notification.

The Contractor shall submit full details of his maintenance and repair service facilities, including statutory holidays, weekends, after hours and normal hours.

The Contractor shall stock the spares during the Defects Notification Period. All repairs to be made to the installation due to causes not covered by the guarantees shall be done utilising the above material.

At the end of the Defects Notification Period the remaining material shall be documented and handed over to the Employer for the ongoing maintenance of the installation.

**38.33 QUALITY CONTROL FOR ELECTRICAL WORKS****38.33.1 Responsibility for Quality**

This part of the Specification shall be read in conjunction with the Contractor's Quality Management System which shall be in accordance with ISO 9000.

The Contractor shall implement a comprehensive Quality Control Plan and accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Engineer or his appointed representatives.

In keeping with the principles contained in the above mentioned code of practice, the Contractor or any nominated and approved Subcontractor(s) shall -

- Be responsible for compliance with all the Clauses of this Specification in every respect;
- Carry out all Factory Acceptance and Site inspections and tests called for in the Specifications in the presence of the Engineer or his appointed representative. The cost of these inspections and tests shall be included in the Tendered rates; and
- Draft a quality control plan for manufacturing indicating all the intended stages of testing during manufacture as well as hold points for independent quality surveillance and testing.

The quality control plans will not be compromised once in agreement and shall be adhered to at all times.

### **38.33.2 Notice of Inspection**

The Contractor shall give the Engineer not less than 14 days' notice in writing of the date and the place of impending inspections or when cleaning and first coat application are to be carried out as well as for witnessing the points in terms of the agreed Quality Control Plans and he shall give the Engineer full facilities for witnessing such tests.

### **38.33.3 Contractor Qualification**

The Contractor and Subcontractor(s) shall satisfy the Engineer that they have the management, facilities and equipment, skilled staff, a quality control procedure and required test methods and standards to carry out quality control during manufacture of electrical Plant.

The above-mentioned Contractors will be subject to a Quality Audit.

### **38.33.4 Submission for Approval**

The Contractor shall submit the following to the Engineer, including data sheets where applicable, for approval:

#### **38.33.4.1 For Manufacture:**

- Drawings;
- A programme;
- A quality control plan; and
- A draft Operation and Maintenance manual.

#### **38.33.4.2 For Corrosion Protection:**

- A programme;
- The Quality Control Plan for corrosion protection duly completed;

- Blast material;
- Coating products; and
- Pickling and passivating products.

### **38.33.5 Manufacture Programmes**

The manufacture programmes shall state the time and place when the following will be conducted:

- Inspection of enclosures and material; and
- Testing.

### **38.33.6 Substandard Quality Control**

All material, certification and records of the Contractor shall be subject to examination by the Engineer.

This shall include the checking and testing of the Plant. If any deviation is found, additional testing and quality surveillance shall be carried out.

If the additional testing confirms inaccurate quality control by the Contractor, all work shall be stopped and shall only proceed after remedial action has been implemented.

### **38.33.7 Access for Surveillance**

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the Contractor's premises relevant to the work being carried out, at any reasonable time.

The Contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated or are in the process of being coated.

### **38.33.8 Cost of Quality Control**

The cost for quality control shall be included in the rates.

When surveillance results in rejection of the lot or when notice by the Contractor results in a fruitless trip, the cost borne by the Inspector / Engineer shall be debited against the Contractor's account.

Where Plant or services fail to meet the Contract requirements but are nevertheless accepted at an agreed revised price, the costs with regard to inspections, tests and analyses shall be for the Contractor's account unless otherwise directed by the Employer.

### **38.33.9 Non-Compliance with the Specification**

Plant, materials and services that do not conform to the requirements of this Specification shall be rejected.

Such rejected Plant shall be held at the cost and risk of the Contractor who shall, when called upon, and at his own cost, repair the defects or corrosion protection according to the Contract.

Failing satisfactory repair of rejected Plant, the Plant shall be returned to the Contractor at his cost and risk without any opportunity to substitute the rejected Plant. Alternative Plant may be purchased at the Contractor's expense or an approved Contractor may be employed to do the repair to the corrosion protection.

Should the Contractor fail to comply with the provisions of the Specification, the Taking-Over Certificate shall not be issued.

### **38.33.10 Acceptance**

No Plant shall be accepted nor be delivered to site unless all Quality Control requirements have been complied with.

## **38.34 QUALITY CONTROL RECORDS**

### **38.34.1 Coating and Material Records**

Quality control, material and coating records for all stages of the work, i.e. batch numbers of materials used, environmental conditions and all test data shall be recorded on the approved Quality Control Plan for manufacture and the Quality Control Plan for corrosion protection.

Certificates for all materials used shall also be required.

### **38.34.2 Data Sheets, Specifications and Codes of Practice**

The Contractor shall have available the latest issues of the following:

- A copy of this Specification;
- Relevant Standard Specification and Codes of Practice;
- Drawings; and
- Manufacturer's data sheets for materials to be used.

The above mentioned shall be available to all the Contractor's Quality Control and Production personnel.

### **38.34.3 Quality Control Records**

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

All the quality control records shall be available for inspection by the Engineer or his representative.

Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the Specification.

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

The records shall be bound in the Operation and Maintenance manuals where such manuals are supplied.

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**38.34.4 Provision for Testing**

The Contractor shall at no additional cost provide all material, samples, labour and the necessary calibrated instruments which may be required for the purpose of inspection, testing and analyses, unless otherwise specified.

**38.35 QUALITY SURVEILLANCE BY THE ENGINEER****38.35.1 Inspection by the Engineer and/or Approved Inspection Authority (AIA)**

Inspection of Plant shall be carried out by the Engineer and/or an AIA at the manufacturer's works.

The Engineer's and AIA's inspections shall in no way relieve the Contractor or Subcontractors of any of their obligations to design, manufacture, test, inspect and supply Plant of superior quality and workmanship in accordance with the specification.

The Engineer and AIA have the right to inspect any item covered in the Contract at any stage of execution of the Contract.

Where imported supplies are to be inspected before shipment, the Contractor shall notify his suppliers abroad of the conditions applicable to inspections and also notify the Engineer and AIA when consignments are ready so that arrangements for inspection may be made.

**38.35.2 Material Tests**

The Manufacturer's material test data certification and the Contractor's quality records shall be subject to examination by the Engineer or his representative.

**38.36 DRAWINGS****38.36.1 Drawings Issued by the Engineer**

The Drawings that were issued as part of the Tender documentation are not manufacturing Drawings and the dimensions given are only sufficient for tendering purposes or to enable the Contractor to complete his working drawings.

**38.36.2 Contractor's Drawings**

The Contractor shall submit drawings for the following purposes:

- Concept Design : for assessment.
- Manufacturing (Workshop) : for approval.
- Installation : for approval.
- 'As-built' : for records.

**38.36.3 Concept Design Drawings**

- a) The Contractor shall submit concept design drawings for review by the Engineer before commencing with manufacturing drawings.



- b) Concept drawings submitted by the Contractor shall give sufficient information to make a proper assessment of the Plant offered together with sufficient detail to enable the dimensions and general arrangement of the Plant to be determined. All the important parts shall be shown in detail, i.e. gate body, scaling arrangements, bearing arrangements, guides, wheels, etc.
- c) Drawings shall include details of parts to be built into, and loads to be transferred to, the civil engineering works, routes and sizes of cabling, cable ducts or trunking, hydraulic pipework, description of erection methods, operating and control units, position indicators and details of connections to any other Plant.

#### **38.36.4 Manufacturing (Workshop) Drawings**

- a) Before commencing with fabrication, drawings in triplicate shall be submitted for approval by the Engineer. These drawings shall cover the general arrangement, assembly and supporting detailed drawings of the Plant offered and their related ancillary Plant.
- b) The drawings shall provide complete information regarding thickness and types of material, finishing of surfaces, fixing and connections, standard parts, tolerances, clearances with regard to other machine parts or building faces and in general everything that may have a bearing on the satisfactory fabrication, erection and operation of the Plant shown on these drawings.
- c) Electrical Plant wiring and or hydraulic diagrams for the sub-assemblies such as distribution and control boards, as well as overall integrated cabling and wiring diagrams for the complete installation, shall be prepared and submitted in a similar fashion to these drawings.
- d) These drawings shall be submitted within the period(s) as indicated on the Construction Programme and agreed with the Engineer. All drawings submitted must signify authorisation by the Contractor. Submission of the Contractor's drawings shall be accompanied by one or more updated index sheets prepared on A3-size sheet, listing all drawings with numbers, titles and status of amendments.
- e) Two weeks after submission by the Contractor, or 10 days in the event of re-submission, the Engineer will return one of the above-mentioned prints either with his certified approval or else with his comments regarding any amendments that may be required. A drawing returned to the Contractor for amendment purposes shall be re-submitted in its amended form within 2 weeks of the date of receipt of the drawing by the Contractor.
- f) Approval of the above drawings by the Engineer shall only signify approval of the general design and layout and shall not make the Engineer liable for any error by the Contractor.
- g) Priority shall be given to those drawings regarding items that affect the concrete or other construction work of a civil engineering nature. These drawings shall detail in full, the necessary provisions to be made in the concrete or other supporting structure(s) for casting in of embedded parts and anchors for fixing of built-in parts and Plant.
- h) All the foundation details and the positions and dimensions of all connecting rods, pockets, vent ducts, cable ducts, anchor bolt holes and similar items, as well as aligning, fixing, anchoring and second stage concrete requirements must be clearly indicated and detailed on these drawings with the general requirements for built-in parts.
- i) The magnitudes and directions of all forces and loads, both static and dynamic, exerted by the Plant on the supporting concrete structure shall be clearly and fully detailed on the Contractor's drawings. Any special requirements to prevent transmitting possible vibrations must also be shown.

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**38.36.5 Installation Drawings**

- a) Not later than 21 days after the proposed Plant has been given approval, drawings shall be submitted to allow for adequate site preparation before the arrival of the Plant. These drawings shall offer the necessary details for the programming of civil works, including foundation details and anchor bolts.
- b) The Engineer has the right to suspend manufacture until a set of drawings, calculations, a draft Operation and Maintenance Manual and Quality Control Plans (for the manufacture and corrosion protection including data sheets of paint and abrasives used) are in his possession and approved in principle.

**38.36.6 “As-built” Drawings**

- a) On completion of the Works, the Contractor shall deliver to the Engineer's office one complete set in triplicate of high quality paper copies together with an electronically saved version preferably on Compact Disc of the Contractor's drawings, updated to reflect the as-built information. These drawings must be clearly marked as “as-built”.
- b) These drawings shall contain general arrangements, assemblies, parts lists (including part numbers) and complete component details as well as wiring and hydraulic diagrams. These items are required in draft form before the Tests on Completion are commenced and in final form before Taking Over in terms of the General Conditions of Contract.
- c) Layout Drawings shall be marked up by the Contractor showing all dimensions to buildings, including the relative positions of underground cables.

**38.36.7 Drawing Format**

- a) Drawings provided by the Contractor shall be to scale size A3 produced in hard copy and electronically in .pdf format. Each drawing shall incorporate a standard project title block, to be provided by the Engineer, and shall show the following particulars in the lower right hand corner:
  - Name of Employer;
  - Name of Engineer;
  - Name of Contractor;
  - Project title;
  - Contract number;
  - Title of drawing (Location, item and detail);
  - Scale;
  - Date of drawing;
  - Details of electrical supply (where applicable);
  - Drawing number; and
  - Revision identification.
- b) Dimensions on all drawings shall be metric.
- c) A blank space 45 mm by 30 mm shall be provided as an extension of the title block for the Engineer's approval stamp. Provision shall be made for details of revisions to be recorded above the title block. Prints of drawings shall be in the form of black lines on a white background.

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**38.36.8 Notes and Part Lists**

- a) Notes on the drawings shall be in English and dimensions in the metric system in SI units with all scales clearly stated.
- b) The Parts Lists shall be part of the assembly drawing unless otherwise agreed to by the Engineer.

**38.36.9 Drawing Identification and Number**

- a) All drawings shall be consecutively numbered.
- b) Each drawing shall be provided with a title block as per the construction drawings issued by the Engineer. A pro-forma drawing frame and title block is available electronically from the Engineer.

**38.36.10 Quality and Format of Drawings**

- a) The standard of draughtsmanship and detailing shall conform to the requirements of SANS 10111 & 10143. Drawings shall be clear, black line on white paper, unfolded and suitable for microfilming purposes.
- b) Unless otherwise agreed to by the Engineer, the Contractor's drawings shall be prepared on A3-size (297 x 420 mm) high quality paper. The size of the drawing shall not compromise the clarity of the prints.
- c) Drawings shall be submitted in hard copy and electronically in pdf format.

**38.37 NOTICES AND LABELS**

All notices, labels and designations shall be in English. A list of wording, terms, designations etc., shall be submitted for approval before manufacturing of labels and notices commences.

**38.38 UNIFORMITY OF PLANT**

Where a specific make and type of Plant has been agreed at award of the Contract, the Contractor shall not deviate from the use of this product without the approval of the Engineer.

**38.39 WORKMANSHIP**

The Contractor shall only employ competent staff to execute the installation.

The Contract shall be executed with the best workmanship in a workmanlike manner and to the satisfaction of the Engineer.

Should any material or workmanship not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Contractor and all rejected material shall be removed from site.

The Contractor shall be responsible for the correct and complete erection of the Installation. Inspections by the Engineer shall not release the Contractor from this responsibility.

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**38.40 SUPERVISION**

The Contractor shall provide full time supervision while staff is working on the Contract.

The person nominated by the Contractor to supervise the Works shall have the authority to take instructions on behalf of the Contractor.

**38.41 SPARE PARTS REQUIREMENTS**

The Contractor shall list and price the spare parts considered to be necessary as required for the continued operation of all mechanical, electrical and electronic Plant based not only on a reliability analysis of the Plant, but also on the reliability and availability of local suppliers of spare parts. The lists shall also include all long lead maintenance items and special maintenance tools that will be required during the maintenance of the plant by the Contractor. The lists of additional critical spare parts must be submitted to the Engineer prior to achieving RFTO.

The total amount for spares derived from for each part of the Works shall be carried forward to the Bill of Quantities. A provisional sum will be allocated in the Bill of Quantity for the complete list of spare parts as listed by the Contractor.

**38.42 MEASUREMENT AND PAYMENT**

For measurement and payment refer to Section 39 – Electrical – Plant and Installation.