
Section D Detailed Electrical Specifications

Part 2 – Pump Station 34

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PSE PARTICULAR SPECIFICATIONS ELECTRICAL

PSE 1 SCOPE: GENERAL

The proposed PS34 Archimedes Screw Pump Station is a new pump station to be constructed at the site of Vereeniging's Leeuwkuil Waste Water Treatment Works.

The design of the pump station allows for an ultimate three screw, screw pumps. The maximum expected power output of each pump shall be 132kW; however the actual motor ratings are still to be determined by the Contractor. Only two of pumps will be installed in this Contract and the third pump will be installed in a future phase.

The following equipment and installations will be involved in the completion of the Electrical works for this contract:

Medium Voltage (MV) Works & Miniature Substation

- a) A new 315kVA, 11kV/0.4kV Miniature Substation
- b) A new MV Ring Main Unit (RMU), Oil insulated, non-extendable, Outdoor IP54, which will be necessary to extend the existing MV network
- c) New MV cable, installed direct in ground, including trenching

Low Voltage (LV) Works & Motor Control Centre (MCC)

- d) New Archimedes screw pumps, complete with motor, gears, etc. The requirements for these are specified in the mechanical specifications, but the electrical Contractor must be familiar with the equipment being supplied.
- e) Local Stations (E-Stops) at the Pump sets
- f) A new Outdoor Motor Control Centre (MCC), complete with motor starters, motor protection, Variable Speed Drives, , Telemetry, Programmable Logic Controller (PLC), Machine level Human Machine interface (HMI), battery backup for the PLC, and all associated wiring
- g) All LV Works, which includes feeders to the Pumps, the Miniature Substation, the Generator, etc., as well as small power such as lighting, socket outlets, and associated installations such as cableways, conduit and accessories.
- h) PLC and HMI programming
- i) Certificates of Compliance (COCs), As-Built drawings and documentation.

Extra Low Voltage (ELV) Works, PLC automation, and process instrumentation

- j) A Programmable Logic Controller (PLC) incorporated into the MCC, as well as the programming thereof
- k) Radio Telemetry Outstation, complete with Antenna
- l) Radar Level sensor, Float Limit Switches and Radio Frequency (RF) Admittance Level switches installed inside pump station wells at selected positions.
- m) Thermal switches in the motor windings and motor bearings, as well as the screw pump lower bearing
- n) Vibration sensor (accelerometer) in the screw pump lower bearing for continuous monitoring and trending of the screw pump bearing.
- o) All control wiring, armoured, between the MCC and the above-mentioned instruments, and associated stainless steel field equipment boxes for terminations where required.
- p) Control wiring between the MCC and Safety Emergency Stop (E-stop) 'Local Station'.

Standby Diesel Generator

- q) A new 375kVA (prime) @ unity power factor Standby Generator with weatherproof canopy and fuel base tank.

NOTE: The new electrical installation shall be sized and installed for the ultimate three pump design, except for the following equipment which will be supplied and installed in a future phase:

- Variable Speed Drive (VSD) for the third, future, pump. The MCC compartment shall only be pre-wired and a circuit breaker shall be installed to accept a future VSD without the need for interrupting supply to the existing sets.
- Feeder cable to the future third pump.
- E-Stop to the future third pump.

The rest of the installation shall be installed as if for a full designed-capacity pump station.

PSE 1.1 Scope: MV Works and Miniature Substation

Drawings

The following tender drawings are issued and shall be read in conjunction with this document:

Drawing No	Description
J35047A2-E01	Leeuwnkuil Pump Station Upgrade: Motor Control Centre Electrical SLD and General Arrangement
J35047A2-E02	Leeuwnkuil Pump Station Upgrade: Instrumentation Details and Schematics
J35047A2-E03	Pump Station 34: medium Voltage Distribution

Background

The Leeuwnkuil works takes its supply from the Emfuleni Municipal Point of Supply, which is located inside a brick structure at the boundary of the WWTW site. The supply is served at a nominal 3ϕ , $11kV_{rms}$.

Two runs of Cu $185mm^2$ paper Insulated Lead Covered (PILC) cables take the supply to the works MV Substation (BNR S/S), where it is received by two 630A, metal clad REYROLLE PARSONS Vacuum circuit breakers (VCBs) (withdrawable). The age of the installation is approximately 20 years.

These two VCBs count two out of a total six VCB's in the substation's MV panel. All of the VCBs are of the same size and type. The other four circuit breakers supply feeders and transformers as follows:

1. Local 1 000 kVA transformer
2. Local 1 000 kVA transformer
3. Feeder to Old Works
4. Feeder to a ring main unit and 31215 kVA transformer at the Digester House

It is proposed to cut into the feeder to the Digester House and sub feed from this to the new Pump Station. Various changes to the proposed future works have occurred during the compilation of this tender document and it is possible that there might be a more cost effective method of supplying Pump Station PS34, for example as a sub feed to the feeder to the "Old Works".

For the purposes of this tender it will be assumed that the feed to PS 34 will be done as a sub-feed to the feed to the Digester House as indicated on the drawings and as described hereunder.

The positions of the Substation BNR, the Digester House and the proposed new Pump Station PS34 are shown on the drawings.

The following GPS co-ordinates are available:

- | | |
|---------------------------------------|------------------------------|
| • Leeuwkuil WWTW Main Entrance Gate | 26°40'19.58"S, 27°53'55.41"E |
| • P.O.S Municipal Substation S/S LWK6 | 26°40'18.65"S, 27°53'55.43"E |
| • Leeuwkuil MV substation (BNR S/S) | 26°40'24.93"S, 27°53'46.48"E |
| • Digester House | 26°40'24.35"S, 27°53'42.28"E |

Therefore:

Works Description

The extension of the Digester feeder shall form part of this contract. The extension shall require the following activities and equipment:

- a) Supply and install a new 315kVA Miniature Substation (minisub) indoors at the location of the proposed new PS34 Screw Pump station.
- b) Install an earth mat for the minisub
- c) Carefully excavate to locate the route of the MV cable feeding from Substation BNR and agree with the Engineer on a position for installing a new outdoor Ring Main Unit (RMR).
- d) Install the RMU in this position.
- e) Install an earth mat for the RMU.
- f) Excavate to expose a length of this cable.
- g) Disconnect and earth the cable and rack out the circuit breaker supplying it.
- h) Cut the cable and re-route the cable so that the part of the cable feeding to the Digester House can be terminated on the RMU
- i) Terminate the cable on the fused isolator of the RMU.
- j) Install a length of cable to connect the RMU to the BNR Substation.
- k) Terminate one end of the cable on one of the isolators of the new RMU and joint the other end of the cable to the cable coming from the isolator in the BNR Substation.
- l) Open the other isolator of the RMU and earth the cable termination bushings
- m) Rack in the feeder isolator at the BNR Substation and re-connect supply to the Digester House
- n) Consult with the Engineer and adjust the trip settings for the feeder circuit breakers so as to provide discrimination between this and the RMU fuses.
- o) Excavate and install a length of MV cable from the new RMU to the new minisub at PS 34 and terminate the cable at both ends.
- p) Include a 3 meter diameter loop of cable for connection of future works. The position of this is notionally indicated on the drawings; however the actual position shall be agreed with the Engineer on site.
- q) Supply and install concrete markers at selected locations along the route of the MV cable.
- r) Close the relevant isolator and circuit breakers and commission the new Miniature Substation.

The feeder's REYROLLE PARSONS MV circuit breaker inside BNR S/S, based on a visual inspection, appears to be in a relatively good condition despite its age. A Provisional amount is allowed in the BOQ in the event refurbishment is required.

Background

Three 132kW screw pumps (Contractor to confirm final motor size) are proposed for PS34. Two of these will be installed in this contract, and the third in a future contract.

The pumps are rated at an operational voltage of 400Vac, and shall take a supply from a new MCC, which takes its supply from either the new 315kVA Miniature Substation or the new Diesel Standby Generator.

The MCC shall be supplied and installed as part of this contract. The pump motors shall be protected and controlled by the starters built into the MCC. The MCC shall be installed on a purpose built plinth, adjacent to the miniature substation, and shall be constructed for an outdoor, and vandal resistant, installation.

The motor starter for each motor shall be a VSD installed in the MCC, in a dedicated MCC 'bucket'.

Works Description

The LV works includes the following activities and equipment and associated work:

- a) Supply and install a new MCC in the MCC room.
- b) Supply and install LV feeder cables from the MCC to the local stations installed adjacent to the pump motors and from there to the pump motors.
- c) Supply and install supply cables from the miniature substation to the MCC.
- d) Similarly, supply and install supply cables from the Standby Generator to the MCC.
- e) Install cable routes and containment to, and inside, the PS34 pump station
- f) Terminate the cables on the MCC, isolators and pumps.
- g) Supply and install local stations adjacent to the pumps. These local stations, also known as E-stops shall comprise the following as indicated on the drawings:
 - Local start pushbutton
 - Emergency Stop Pushbutton
 - Three pole 250 A on-load switch disconnect
- h) Supply and install lighting to the plant building
- i) Supply and install all LV and ELV wiring
- j) Commission, test and issue CoC

PSE 1.3 Scope: ELV Works, PLC automation, and process instrumentation

Background

The MCC shall be supplied complete with a PLC and associated power supplies, Uninterrupted power supply (UPS)UPS, relays, wiring and terminals. The tenderer shall include all programming of the PLC in his cost.

The pumps shall be VSD driven with an interface to the PLC. The PLC shall control the pumps to:

- a) Match the pump station outflow with the inflow demand
- b) At the same time, if possible, operate at a speed that is optimised for power consumption efficiency

The interface between the VSD and the PLC shall be seamless, and of a Modbus or Profibus protocol or other suitable industry accepted protocol.

The PLC shall also conduct supervisory functions, and share selected key readings and alarms with the regional SCADA via telemetry.

The PLC shall receive the following information from the pump station's instruments:

- a) Wet-well water level (Continuous readings)

- b) Overflow and drywell conditions (from level limit switches)
- c) Output from monitoring sensors such as Thermal PT100 sensors in the motors and bearings, as well as vibration sensors at the lower bearings of the screw pumps.

At present, the regional SCADA system is not operational. A machine level HMI system will therefore be required at the MCC to view the status and condition of the pump station, as well as historical trends for selected parameters. The HMI shall display, from a default window, the running status of the pump station. From supplementary windows, the HMI shall display historical trends, alarms, etc. These data key points shall be drawn from the PLC, i.e. all memory shall be held on board the PLC internal memory module.

Works Description

The Process and Automation works installation will require the following activities and equipment:

- a) PLC supplied and installed in the MCC and programming thereof.
- b) One Radar guided level sensor.
- c) Three ball float switches
- d) Four RF admittance level switches complete with probes up to 5m.
- e) Twelve PT100 Thermal sensors for the Pump Motor windings and bearings
- f) Three PT100 thermal sensors for the Screw lower bearing
- g) Three Vibration sensors for the screw lower bearing
- h) Telemetry Outstation.
- i) Machine level HMI supplied and installed inside the MCC, and programming thereof
- j) Battery backup
- k) Associated wiring, field equipment boxes and accessories
- l) Testing and Commissioning

This concludes the Process and Automation scope of the project.

PSE 2 Site Details and Conditions

The PS34 will be constructed at Vereeniging's Leeuwkuil Waste Water Treatment Works.

The tenderer shall take note that their electrical equipment and installations will be installed in an extremely corrosive and damp environment. The equipment material selection and construction shall therefore be suitably applicable for this environment.

For site orientation purposes only, the approximate GPS co-ordinates for the proposed PS34, and other relevant waypoints at the WWTW, are quoted here:

- | | |
|---------------------------------------|------------------------------|
| • Leeuwkuil WWTW Main Entrance Gate | 26°40'19.58"S, 27°53'55.41"E |
| • P.O.S Municipal Substation S/S LWK6 | 26°40'18.65"S, 27°53'55.43"E |
| • Leeuwkuil MV substation (BNR S/S) | 26°40'24.93"S, 27°53'46.48"E |
| • Digester House | 26°40'24.35"S, 27°53'42.28"E |
| • Proposed PS34 (location TBC) | Refer drawing |

PSE 3 Statutory Regulations pertaining to Electrical Work

Works shall be performed in accordance with statutory regulations

PSE 4 Municipal Electrical Connection

As mentioned in PSE 1.1, the Leeuwkuil Waste Water works is Council supplied from a dedicated Municipal Substation, S/S LWK6, at the Boundary of the ERF (near to the Main entrance gate to the works). The supply is served at 11kV.

Two spur feeds are taken from S/S LWK6 to the works' MV Substation (BNR S/S). From there the supply is distributed to the various load centres around the water works.

The Contractor is not required to submit to council an application for an electrical connection for PS34. The supply shall be taken from one of the BNR S/S feeders as described in the following section, PSE 5.

PSE 5 WWTW MV Substation (BNR S/S)

BNR S/S, the works' main substation, is located approximately in the centre of the Leeuwkuil WWTW site. The substation houses one Medium Voltage (MV-11,000V) panel, consisting of:

- Two intake MV circuit breakers and
- Four feeder MV circuit breakers.

The circuit breakers are the metal enclosed, vacuum type withdrawable circuit breaker variant, complete with IDTM, DT, Earth Fault and Instantaneous trip mechanical relays.

The Substation receives the two MV Council supplies mentioned in PSE 1.1 and PSE 4 at the two intake feeders.

The two supplies are consolidated into a 630A, MV busbar inside the MV panel. The supply is then distributed to the following secondary substations inside the works:

- BNR Substation (Two MV feeds, each supplying a 1 000 kVA transformer)
- Old Works (Single MV feed, supplying an 800 kVA transformer)
- Digester House (Single MV feed, supplying a 315 kVA transformer)

The MV distribution board is approximately 20 years old, manufactured by REYROLLE PARSONS. ABB South Africa have taken over the servicing of this brand of switchgear. The switchgear appears to be in a serviceable condition. No records however were available at the time of writing that suggests the switchgear has ever been serviced.

At present, the Contractor will not need to conduct any alterations or repairs to the BNR S/S MV panel. Only MV switching will be required. The Digester House feeder will need to be switched because the feeder is to be extended to PS34 (See the next item, PSE 6).

A monetary amount is allowed for servicing nevertheless to cover necessary remedial works, if any, in order to continue with the PS34 installation.

It should be noted that the MV panel in the BNR substation will be comprehensively refurbished at a later time, in a future project planned for the works.

PSE 6 Digester House

The building known as the Digester House is an existing, brick built house located to the west of the existing Biological Nutrient Reactor and next to one of the existing Final Clarifiers.

Electrical equipment installed there comprises the following equipment:

- A single MV, Oil isolator
- A 315kVA transformer, ONAN
- A Motor Control Centre

The condition of the MV Isolator appears serviceable. The transformer and MCC appear in reasonable condition.

- a) to the new RMU.

PSE 7 PS34 MV Supply Cable

Refer PSE 1.1 above.

The Contractor shall install the following:

- New RMU
- Cable link from the BNR Substation to the RMU
- Termination of a cable from the RMU to the Digester House
- A new MV cable from the RMU to the new minisub at PS 34. All necessary excavation, backfilling and compaction

The length of the cable route is approximately 385m. The cable shall be the Type A XLPE Insulated, Tape Screened, PVC bedded, Galvanised steel wire armoured, PE sheathed cable as specified in SANS 1339, complete with water blocking.

PSE 8 PS34 Miniature Substation: General

The Contractor shall supply and install a new 315kVA miniature Substation at the PS34 pump station. The miniature substation will be dedicated to the pump station.

PSE 8.1 PS34 Miniature Substation: Transformer Rating

The Miniature Substation's transformer shall have the following ratings:

- | | |
|---|------------------------|
| • Transformer power rating | 315 kVA |
| • Nominal voltage of system | 11.5 kV _{rms} |
| • System frequency | 50 Hz |
| • Number of phases | Three (3) |
| • Nominal no-load secondary voltage | 420 V _{rms} |
| • Rated power frequency voltage | 12 kV _{rms} |
| • Rated lightning impulse withstand voltage | 95 kV peak |
| • Rated short-duration power frequency withstand voltage (50Hz : 1 min) | 28 kV _{rms} |
| • Induced voltage withstand level | 22 kV _{rms} |

PSE 8.2 PS34 Miniature Substation: Construction

The construction of the Miniature Substation shall be modular. The following requirements apply (PLEASE TAKE NOTE OF THE REQUIREMENTS FOR VANDAL RESISTANT MEASURES):

- Require removable base sections adjacent to MV compartment (sections to be lap bolted with nuts on the inside of the channel and housing).
- Require concealed door and roof hinges.
- Compartment fastening/locking (Pad lockable) require three point locking with one additional 10mm sunken captive Allen cap screw.
- Provision shall be made for lifting of complete miniature substation onto a concrete plinth without need for dismantling.
- Provision shall be made for lifting lugs on roof for ease of removal.
- In terms of NRS 004 the MV switchgear, LV panel and transformer shall be housed in separate compartments.

- All miniature substation-housing sections/doors to be earth bonded.
- The Housing construction is to be of 6mm Mild Steel

PSE 8.3 PS34 Miniature Substation: Transformer Unit

- Electrical requirements As per SABS 780
- Vector group Dyn 11
- MV system earthing Eskom Specification
- LV transformer neutral earthing Eskom Specification
- MV system fault level 25 kA
- Temperature rise limits As per SABS 780 : Table 6
- Secondary voltage regulation (%) -5.0%, -2.5%, +2.5%, +5.0%
- The transformer unit to be sealed (Welded cover)
- The transformer MV bushings internal screen to be earthed and to comply with BS7215

Clearances:

- MV bushing-centre clearances 105mm (minimum)
- Outer bushing-centres and minisub metal enclosure 90mm (minimum)
- The winding material (MV and LV) to be Copper
- All miniature substation-housing sections/doors to be earth bonded.

PSE 8.4 PS34 Miniature Substation: MV Compartment

The MV compartment shall be equipped with an RMU comprising two oil filled isolator and one fuse switch complete with cable endboxes suitable for terminating the 11 kV cable specified elsewhere herein.

The MV compartment shall have a front door only.

Incoming MV cable requirements:

- Two x 3-core (The second cable shall be installed in a future phase to complete an MV ring)
- Cable material : Copper
- Maximum size of core cross section : 95 mm²
- Type of cable : XLPE
- Cable support (clamping) is required
- Cable identification tags

Allow for ac earth fault indicator (SCSSCABA9)

PSE 8.5 PS34 Miniature Substation: LV Compartment

A main 630A (settable) LV MCCB shall be provided in the LV compartment to isolate the LV busbar from the transformer.

The circuit breaker shall comply with the requirements of IEC 60947.

The Busbar rating shall be a minimum 630A. In terms of NRS 004 the current density of the busbars shall be 1.8 A/mm² maximum.

The rated withstand current shall be 25 kA for 1 second.

The minimum clearance to earth and between phases shall be 20mm.

An LV neutral surge arrester shall be fitted between the mini substation earth bar and LV neutral earth busbar.

The LV neutral earth busbar shall be earthed (via an electrical bridge to the miniature substation's earth bar).

Provision shall be made for one only outgoing LV feeder (drill busbar Ø 14 mm holes, 110 mm spacing between holes).

Spacing (vertical):

- Between phase busbars : 185 mm
- Between lowest LV busbar and LV neutral : 300 mm
- Between LV neutral and gland plates : 200 mm

LV maximum demand Ammeters are required on all three phases. A Thermal integrating over 15-min-period Ammeter shall be provided.

An LV indicating voltmeter (with a selector switch) shall also be provided.

The Ammeter and voltmeter shall be positioned on the top right hand side in LV compartment and have the following size and display : 96 x 96 mm, 90°.

A non-flammable removable barrier shall be provided to separate the LV end compartment and front LV compartment.

PSE 8.6 PS34 Miniature Substation: LV Feeder Bay Gland Plates

The following shall be provided:

- One gland plate per LV feeder bay
- Two gland holes per LV feeder bays
- The hole sizes: 1 x M63
 1 x M32
- The distance between gland plate centre lines to be 110 mm.

PSE 8.7 PS34 Miniature Substation: LV Auxiliaries

The following shall be provided:

- The provision of a three point socket outlet in LV compartment (with instantaneous-trip earth leakage unit [20 A; 5 kA rupturing capacity, 30 mA sensitivity and 63 A High Rupturing Capacity (HRC) fuse with neutral fuse link].
- Provision of a tamperproof compartment for the installation of a photocell.
- 300 mm x 300 mm blank plate for PECU.
- Numbering ferrules for auxiliary wiring.

PSE 8.8 PS34 Miniature Substation (Minisub): Materials and Corrosion Protection

The minisub enclosure, transformer tank and radiator shall be manufactured from 3CR12 or Zinc sprayed mild steel to Eskom Distribution Specification SCSSCAAP9. The Mild steel shall be 6mm, for the roof and housing.

The busbars shall be tinned copper.

The minisub base:

- Shall be manufactured from steel
- Corrosion specification: Hot-dipped galvanised with black epoxy tar paint to SABS ISO 1461.
- The gland plate shall be manufactured from 3 mm mild steel, 3CR12 or stainless steel.
- If manufactured from mild steel the gland plate shall be hot-dipped galvanised to SABS ISO 1461 or Zinc sprayed.

The gland plate support structure shall be manufactured from steel and corrosion protected by hot-dipped galvanising to SABS ISO 1461 or Zinc sprayed.

Provision shall be made for 5 mm cork packing between ends and tank, base and ends, and base and tank.

The final colour shall be Avocado C12.

PSE 8.9 PS34 Miniature Substation: Concrete Plinth

The minisub plinth shall be pre-cast.

A 20 mm thick wax-impregnated polyurethane foam strip ("Sondorband" or similar approved) shall be placed between the minisub base frame and the plinth.

The inside of the plinth shall be filled with sifted sand to a level of 30 mm below the top surface of the plinth. The remaining 30 mm to the top of the plinth shall be filled with a 6:1 sand/cement screed that is neatly levelled and compacted.

PSE 8.10 PS34 Miniature Substation: Notices, Signs and Labels

Transformer rating plate information

The rating plate shall be permanently affixed in a prominent position at the LV transformer terminals so that it is clearly visible when the door to the LV compartment is open. In addition to the relevant requirements of SANS 780, the following information shall be clearly shown on the transformer rating plate:

- Manufacturer's name and year of manufacture.
- Serial number
- Total mass of the minisub.

Signs

A sign depicting "Treatment and Full First Aid Instructions" shall be permanently attached to the inside of the MV and LV compartment doors.

External aluminium or 'Chromadek' electrical symbolic MV warning signs and LV warning signs shall be permanently attached to all the doors. If pop-rivets are used to attach the signs to the minisub doors, only aircraft or blind pop-rivets will be acceptable.

The barrier used to barricade the air insulated cable junction box of the 11 kV minisub shall have a sticker applied to it depicting an electrical symbolic warning sign (warning against "Unauthorized entry").

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").

Labels

A unique label shall be assigned to each miniature substation and shall have white lettering on a red background. The background circle shall have a diameter of +/- 300mm.

The white colour shall be Cloud White G80 and the red colour shall be Signal Red A11 as in National Colour Standard for paint SABS 1091/1975.

All characters shall be in white and shall be +/- 50mm high. Lettering shall be uppercase.

Labels shall be painted on the road access side of the equipment.

Labels shall be painted in the middle of the transformer section of the miniature substation against the vertical side, as well as on the inside of the LV door of the miniature substation. Labels must be mounted not more than 100 mm from the roof of the miniature substation under the overhang.

All LV auxiliary and additional equipment provided in the LV compartment shall be labelled and securely fixed by means of pop-rivets.

A label shall be provided in the LV compartment adjacent to the control relay of the temperature-sensing element that indicates the relay setting temperature (e.g. "Temp. setting = 90°C").

Phase labels shall be provided below all the bushings (primary and secondary) of the transformer.

The LV busbars shall be colour-coded in the preferred colours of red, white, blue and black by a clearly visible painted-on spot at least 20 mm diameter.

The primary voltage, secondary voltage and 'kVA' rating shall be neatly and uniformly stencilled on the front, centre (100 mm below the roof) of the miniature substation housing, e.g. "11 kV / 415V 100 kVA". The markings shall be white and in characters larger than 50 mm high.

The corrosion protection category (i.e. "INLAND" or "COASTAL"), total mass (in kg) and Eskom SAP (stock) number shall be neatly and uniformly stencilled on the back of the minisub, e.g. "COASTAL 3500 kg SAP XXXXXXXX". The markings shall be white and in characters larger than 50 mm high.

The labels "MV" and "LV" shall be neatly and uniformly stencilled onto the inside of the minisub MV and LV doors, respectively. Only the doors that open first shall be labelled. The markings shall be white and in characters larger than 50mm high.

Main circuit designation labels that can be removed for engraving purposes shall be provided for each of the incoming cables in the MV compartment. The labels shall be at least 150 mm wide, 35 mm high and shall be blank sandwich-board or equivalent (orange-black-orange).

A label shall be provided in the LV compartment adjacent to the top-oil temperature sensing element pocket that states "CHECK THERMOMETER POCKET FILLED WITH OIL BEFORE COMMISSIONING".

ID markings linking roof to body per batch.

PSE 8.11 PS34 Miniature Substation: Documentation

The following documentation shall be provided:

- a) One set of Type Test Certificate (provide reference numbers of reports).
- b) One set of Routine Test Certificate.
- c) Two sets of drawings.
- d) Two sets of Circuit Diagrams (HV Auxiliary wiring and equipment).

PSE 8.12 PS34 Miniature Substation: Earth Mat

- a) An earth mat complying with Eskom standards shall be installed. Quantities of excavations, copper earth wire etc. have been allowed in the Bill of Quantities. These quantities are re-measurable.

PSE 9 Standby Generator

The Contractor shall supply, install and commission a new 375kVA @ unity power factor, standby diesel generator in a weatherproof sound attenuating enclosure, complete with an integral 999 litre diesel tank built into the frame and a 4 500 litre bulk fuel storage tank with circulating pump and filter to limit algal build-up.

The Generator shall comply with the drawings and the requirements of the standard specifications and additional requirements set out hereafter.

The generator control panel shall incorporate a dedicated, microprocessor based generator controller.

While the rating of the generator is specified in this document, the tenderer shall nevertheless verify that the rating of the generator will suit the load and equipment of the pump station, and in particular will be compatible with the VSD pump drives.

The generator shall be capable of starting and running the pumps as listed below. The final full component of pumps is as follows:

- three 132kW pumps, operating as duty, assist and standby. The efficiency of the motors will be premium efficiency, which implies smaller impedances, higher power factors and higher starting currents, which must be managed by the VSD.
- One 11.6 kW sump pump operating from time to time to clear seepage and controlled by soft starter

The Automatic transfer switch (ATS) shall be installed in the MCC as per the schematic drawing.

This shall comprise two motorised circuit breakers.

Please note the following:

- The ATS controller must be able to perform synchronisation between the Municipal supply and the Generator supply i.e it shall be possible for there to be a seamless transfer of load from generator power back to mains power when power is restored after a power outage

PSE 10 Motor Control Centre: General

One new 400V Motor Control Centres (MCC) shall be supplied and installed by the Contractor.

The MCC shall accommodate:

- The ATS Generator controller
- Electrically interlocked motorised circuit breakers to accept power input from either the new minisub (Mains) or the new standby generator
- the switchgear and control gear for all the motor loads,
- the PLC controller and modules,
- the Telemetry Outstation,
- the HMI,
- the field instrumentation and equipment terminations required for PS34,
- switchgear to provide local small power to the building electrical services such as external lighting and socket outlets.

The construction of the MCC and the selection of switchgear shall comply with the latest revisions and amendments of the relevant SANS and IEC Standards. The design and specification of the MCCs shall also meet the Municipality's requirements and preferences.

The MCC shall generally be modular in structure, floor standing and installed outdoors, exposed to the elements, on a purpose built plinth. The MCC shall accommodate all switchgear and process automation equipment necessary to feed and control the PS34 installation.

The MCC shall be equipped with panel mount combination multi-function digital meters for the measurement and display of all relevant electrical parameters. The minimum parameters displayed shall include:

- Voltage: Phase, line and system voltage values
- Current: Phase current values
- Power: Phase and total active, reactive and apparent power values
- Energy: Active (Import/Export) and reactive (Inductive/Capacitive) energy Power factor
- Frequency of the incoming voltage (not the outgoing feeder from the VSD)
- High and Low: Maximum and minimum instant readings of phase voltage, current, total active power, reactive power and apparent power
- Maximum readings: Maximum readings of current and total active power sampled over a programmed integration area
- Harmonics: 10% THD

Please also refer to PSE 10.5.

PSE 10.1 Motor Control Centre: Electrical

Connected Load

The new MCC shall accommodate supplies to the PS34 screw pumps, the sump pump and local lighting and small power.

Power requirements are tabled as follows:

Plant	Rating	Quantity (Duty)	Total kVA est.
Screw Pump	132kW	3(2)	264kVA
Sump pump	11.6 kW	1	14 kVA
Small Power			2kVA
Sub Total			280 kVA
Diversity			0.9
TOTAL Connected load @ Inlet works (Duty)			240kVA

The Total estimated load for the new MCC is therefore 240kVA.

Note: As the screw pumps are controlled by variable frequency drives the power factor applied to the MCC by the screw pumps will be close to unity.

Note also: There will not be a situation where

MCC Switchgear

1) Incoming Feeders

- a) The MCC shall receive a primary supply feed from the Miniature Substation.
- b) The MCC shall receive a secondary supply from the Standby Generator.

The two feeds shall be integrated into the MCC, and the circuit breakers allocated to each feed shall be as follows:

a) Primary supply feed

Item	Description
Current Rating	(adjustable and set to 400A)
Type	Air, Motorised
Fault rating	15kAmin

b) Secondary (Generator) supply feed

Item	Description
Current Rating	630A (adjustable and set to 400 A))
Type	Air, Motorised
Fault rating	15kA

A dedicated cubicle shall be provided for each of the Incoming Feeders, i.e. in compliance with Form 4a as described in IEC 61439-1-2.

The circuit breaker above shall incorporate:

- a manually and motorised operated spring assisted closing mechanism,
- a shunt trip coil,
- thermal over-current tripping device and
- instantaneous short circuit tripping device
- a facility for padlocking in the "off" position.

The circuit breakers shall be motorised, and electrically interlocked. The circuit breakers shall not be mechanically interlocked, as synchronisation between the Generator and Municipal supply will require a momentary parallel operation.

In the event of a mains failure, the MCC's ATS controller shall initiate the Generator start, and coordinate the changeover between Generator and the Municipal supply.

The following shall also be provided for each feeder:

- One 96 mm flush fitting voltmeter, scaled 0 to 450 volts, and connected to the busbar side of the circuit breaker.
- One set of HRC fuses or 15 kA rupturing capacity circuit breakers for voltmeter protection.
- Three 96mm flush fitting, thermal maximum demand ammeters, suitably scaled.
- Three current transformers for ammeter operation.
- One energy demand meter which shall be interfaced to the PLC.

2) Screw Pump Switchgear and Control

The design of PS34 calls for Three Screw Pumps. The pumps shall be operated in a two duty and one standby arrangement.

The mechanical/electrical properties of the motor driving the pumps is expected to fall within the following tabled ratings.

Item	Description
Motor output rating	132kW

Efficiency Class	Up to IE2 (High efficiency), per IEC 60034-30-1
FLA	Manufacturer specific
FLC	250A @ 400V, per SANS 60947-4-1 Table G
Volt Rating	400Vac, Delta connected
Operation Control	Variable Speed Drive

The starting method for each of the three pumps is Variable Speed Drive.

The MCC motor compartments shall be equipped with:

- Short circuit protection with overload disconnect, which also serves as a switch disconnect.
- Earth leakage protection (which may be integrated into the thermal relay device or VSD)
- Thermal overload, phase imbalance, under voltage and single phasing protection relay device, which may be incorporated into the VSD
- Panel control and visual indicators
- PLC Motor automation control relays and interface

Note that as the motor is controlled by a VSD the current drawn by the VSD will never exceed the full load current of the motor. Moreover, as the power supplied to the VSD is firstly converted to direct current by a rectifier the power factor of the VSD is close to unity. The power factor of the motor will be approximately 0.85; hence the output current from the VSD will be greater than the input current.

Starters in the motor control centre shall all be of the same make when practicable.

The full complement of switching equipment and their ratings for each of the starters is described as follows:

a) Short Circuit and overload protection

One triple pole moulded case circuit breaker capable of interrupting the maximum through fault current. The circuit breaker rating for the 100 kW VSD shall be as follows:

Item	Description
Current Rating	250A, 400V
Fault rating	10kA
Protection	Magnetic and Thermal

b) Variable Speed Drive starter

One Variable speed drive shall be provided in the motor control cubicle for each of the pump motors. The screw pump sets shall be driven by VSDs. The VSDs shall be supplied and installed inside dedicated cubicles within the MCC.

The Contractor shall ensure that all the available safeties within the motor are hard-wired into the VSD control circuits.

The Contractor shall be responsible to ensure that the variable speed drive system, the motor and the PLC are fully compatible as a system.

The VSDs shall be suitable for centrifugal pumps with a squared torque characteristic. The Contractor shall guarantee the availability of spares for 10 years after Contract acceptance.

3) Panel control and visual indicators

Panel mount push button switches shall be provided for the pumps and motors. The push button switches shall be configured for the following action:

- One green “Start” button. This shall initiate the pump start sequence (when in Manual mode).
- One red “Stop” button. This shall initiate the stopping sequence (when in Manual Mode).
- Speed control shall be modulated directly on the VSD HMI (when in the Manual Mode)
- Panel visual indication shall include:
 - One 96 mm flush fitting, direct or current transformer operated ammeter suitably scaled.
 - One current transformer for ammeter operation. Outgoing terminals shall be provided for remote ammeter indication.
 - One running hour meter.
- Panel human-machine indication shall include:
 - One amber "Trip" indicator lamp.
 - One green "Run" indicator lamp.
 - One red "Stop" indicator lamp.

4) Remote “Auto” control

One panel mount rotary type change-over switch for "Manual/Auto/Off" selection, shall be provided for each of the pumps.

The switch shall toggle the starter between automatic pump control (PLC) and local manual control.

Wiring terminals shall be provided for interfacing the starter to the PLC Control. Contacts shall be provided for the following cases:

- One normally open contact for the “Start” sequence (Input signal).
- One normally open contact for the “Stop” sequence (Input signal).
- One auxiliary contact at the rotary switch for auto/manual indication purposes (Output signal).
- One normally closed contact to raise a “Trip” alarm (Output signal).
- A Digital protocol channel link between the VSD and Starter for speed control and seamless communication of alarms and other parameters.

PSE 10.2 Motor Control Centre: Construction and Configuration

The MCC shall be floor standing on a purpose built plinth, installed in the MCC room.

All incoming cables and feeders shall enter the MCC from the top and shall run overhead to and from the MCC.

The Contractor shall ensure that the panel is deep enough to accommodate both busbars linking the components and overhead cable exits.

- The MCCs shall generally be IP55 (Outdoor Rated), and of heavy construction build for resistance to opportunistic vandalism.
- The layout of the MCCs shall adopt a multi-tier, multi-section configuration, form 4a as described in IEC 61439.
- The MCCs shall be fitted with lockable, protruding doors with concealed hinges. The locking mechanism shall be a 3 point locking type with Allen Key bolt mechanism.
- Behind the doors, panel covers to each of the individual motor control cubicles shall be hinged. These hinged panel covers shall not be lockable, but instead they shall be interlocked with their respective isolators or circuit breakers.

The MCC doors and openable panel covers mentioned above shall be rendered dust proof by means of rubber seals fixed or applied to the frame openings, and be made of an elastomer such as expanded neoprene or other compound suited for a potentially aggressive atmosphere.

The MCCs shall be accessible from the front, to access the switchgears and motor starters, and from behind to access the cable terminations and busbars.

The MCC enclosure shall be constructed with folded heavy gauge sheet steel, of minimum 3mm sheet steel. A recessed plinth, fashioned also of a heavy gauge sheet steel and angle section, shall raise the MCC off the floor.

The steel that is proposed for the construction of the MCCs shall be a minimum 3mm thick CR12 low-grade stainless steel. The sheet steel shall be painted inside and out with metal primer and an epoxy based powder coat or enamel.

A urethane overcoat shall also be required over the epoxy coat, for its aesthetic finish, and the UV protection of the epoxy coat.

1) Paint finish and Corrosion protection

Corrosion protection shall be achieved with the application of a thermoplastic coating to the Motor Control Centre's steel construction.

The MCC shall be installed in the MCC room.

The MCC shall be coated with an Epoxy Base coat, and then a coat suitable for protecting the base coat from UV degradation or discolouration. Alternatives to this need to be submitted to the Engineer for review and approval, before application.

Item	Description
SANS Standard	SANS 1217
Coating System	Electrostatically applied Powder, Fusion bonded
Base coat	Thermoplastic, Epoxy
Over coat	Thermoplastic, Epoxy or suitably approved
Coat thickness (total)	<75µm

The MCC colour scheme is proposed in the schedule tabled below. The colour codes quoted in brackets are colour references quoted from SANS 1091. The surface finish for the coating is also proposed in the table.

Component	Description
SANS Colour Standard	SANS 1091
Exterior walls	Signal red (Code A11), Textured, Gloss
Doors	Signal red (Code A11), Textured, Gloss
Panel covers Generator) (Change-over switchgear, VSDs and small power and lighting	Signal red (Code A11), Textured, Gloss
Panel cover (PLC)	Olive Green (Code H05)*, Smooth, Gloss
Demising panels	White, Smooth, Gloss

2) Layout of Equipment

The MCC equipment shall be arranged to provide ample space for wiring, components and switchgear.

All electrical elements of the MCC shall be accessible from the front or the back of the MCC for ease of maintenance and operation.

Furthermore, the starter gear for each motor shall be physically segregated from all of the other starters in the MCC. It shall be possible for maintenance technicians to isolate and repair faulty equipment in the compartments without having to disturb the rest of the MCC or interrupt the service of the pump station.

The design criteria that shall render the MCC compliant with the above conditions can be summarised as follows:

- The motor control units shall be separated from each other, each in a dedicated cubicle (bucket).
- The motor control units shall also be separated from the MCC busbar.
- Finally, the cable terminations of all incoming and outgoing conductors shall feed directly into the relevant MCC cubicle.

The term 'separation' refers to a physical barrier between compartments that prevents a technician from accidentally touching a live conductor in a neighbouring cubicle. This is a legal prerequisite if a MCC is to be worked on while it is still live and in service. The above segregation policy that must be complied with is described by SANS 60439-1, Form Factor 4a.

PSE 10.3 Motor Control Centre: PLC

The PLC system shall be supplied with the MCC.

The PLC shall be a product that is well supported in South Africa and is compatible with the systems that have already been deployed throughout the EMFULENI Municipality.

Proprietary systems that have been developed by the Contractor or a sub-Contractor shall not be encouraged or accepted. The size of the system shall depend on the pump station and shall be based on the estimated number of analogue and digital points for the completed system, with spare capacity for future expansion (See PSE 12).

The PLC equipment shall be integrated into the MCC. The equipment shall include:

- The Controller
- Binary Input and Output Modules.
- Serial Communication modules
- Power Source.
- Surge Protection
- Battery Backup or UPS

Further requirements for the PLC are specified in PSE 11.

PSE 10.4 Motor Control Centre: Telemetry System

The Telemetry outstation shall be supplied with the MCC.

Like the PLC, the Telemetry System shall be a product that is well supported in South Africa and is compatible with the systems that have already been deployed throughout the EMFULENI Municipality. The system presently deployed throughout the municipality, and maintained by VAALTECH (PTY) LTD, is the ELPRO 105U-1 transmitter, together with the ELPRO 115S-11 expansion I/O modules.

An ELPRO gateway, the 105U-G-ET1 gateway, is installed at the EMFULENI offices which consolidates the radio traffic from all the approximately 36 pump stations in the field and channels the data into the ADROIT running PC mentioned above.

The Communication link is transmitted over the 445.0375 frequency band, which is licensed to EMFULENI.

Proprietary systems that have been developed by the Contractor or a sub-Contractor shall not be encouraged or accepted.

The Telemetry equipment shall be supplied with the MCC. The equipment shall include:

- The Controller
- Input and Output Modules.
- Power Source.
- The Telemetry Communication modules and transmitter.
- Surge Protection
- Battery Backup

The PLC shall feed the telemetry system with various data and status information listed in PSE 11.

PSE 11 PLC: General

A standalone programmable PLC shall be provided for the control of the equipment as described in the "Control Philosophy" section PSE 12.

The PLC hardware shall be field-proven under similar conditions and shall be suitably protected against excessive temperature, electrical interface, input and output over voltage or short-circuit and loss of program memory.

The PLC shall incorporate a non-volatile form of program memory, which does not rely on an internal or external source of power to retain program memory in the event of a loss of normal power.

The CPU and I/O modules of the PLC shall be supplied with 20% excess program memory and I/O capacity for initial operation of all specified process components. However, the specifications of the PLC shall allow for future expansion of up to 50% additional memory and I/O capacity.

The PLC system shall be of a modular design with the mounting racks for the central controller, extension racks, power supply cards, central processing units interface cards, 110 cards, etc. interchangeable between the various nodes.

It shall be possible to code cards and slots to prevent the incorrect card being inserted into a given slot. Alternatively, the controller shall employ interrogation software, which shall detect the insertion of an incorrect module and prevent controller operation if an incorrect module is installed,

It shall be possible to change the modules without disturbing field writing. Connection blocks shall plug into the modules and shall be coded, to prevent connection blocks being plugged into the wrong modules. All modules shall have surge protection, which meets the IEEE-472 or similar standard.

All inputs shall have LED status indication on the modules. A maximum of 8 inputs with a single neutral shall be provided per module.

Output modules shall be of the opto-electronic switched solid-state relay (SSR) type. The module shall be able to withstand a peak load of 15A for one cycle and intermittent load of 9A for 3 cycles per channel. For SSR type output modules, fuse terminals with blown fuse Indicators shall be provided at the back of the PLC section of the board. Should the fuse fail

to blow, then the fault shall only affect the switched output, and shall not affect the remaining outputs within the group. All outputs shall have LED indications.

For both the input and output modules, the LED's shall give a true load-side indication to and from the field devices.

Analogue input modules shall be of the multiple input range type. This may be either by means of plug-in type measuring range cards or by dipswitch selection. The input resolution of the module shall be a minimum of 12 bits. All inputs shall be individually isolated. Input modules with LED indication for "Communication Active" and "Out of Range" are preferred. Where a large number of analogue inputs with relatively slow changing values are required to be monitored, use may be made of analogue multiplexer modules. The multiplexer shall be compatible with the analogue input module and shall therefore be supplied by the same manufacturer. The input resolution of the multiplexer shall be 12 bits.

Analogue output modules need not necessarily be of the full multiple output range type. The output resolution shall be 12 bits. The outputs shall be electrically isolated from each other. Output modules with "Communication Active" indicators are preferred. Galvanic isolation in the form of opto-isolators shall be provided for all inputs and outputs and the driving logic of the modules.

The PLC's supplied shall communicate seamlessly with the Telemetry System as specified elsewhere and with the VSDs. Preference shall be given to PLC's from the same make and supplier as the VSDs. The suppliers shall be permanently represented in Gauteng and shall guarantee the availability of local field service facilities and unit replacement ex-stock from the local depot, for one year after the completion of the Defects Liability Period.

PSE 11.1 PLC: Programming and Software

The Contractor shall provide his own computer hardware for programming, testing and commissioning of PLC's.

All PLC programs shall be stored on CD- ROMs or memory stick, from which it shall be possible to download onto the PLC on site by means of a Notebook PC. "Master" and "Back-up" of all programs shall be issued to the Employer after commissioning. In addition to the CD-ROMs or memory stick, a hard copy (printout) of all software shall be provided with the manual.

No special passwords, dongles, or other protection shall be installed or copyrighted which may inhibit access to the software by Employer's technical personnel.

On hand-over of the project a copy of the program and applicable software shall be issued to the Engineer and Employer.

PSE 11.2 PLC: Data Communications

The PLC shall be able to interface with the variable speed drives, field sensors and instrumentation, HMI and telemetry system via open architecture communication with preference given to a Modbus or industrial Ethernet communications network.

The PLC shall be supplied with:

- the necessary modules to interface with each of the three the VSDs proposed for the MCC. The interface shall deliver a seamless communication channel between the PLC and VSDs.
- the necessary modules to interface with the Generator ATS controller. The interface shall allow the PLC to interrogate any of the following information:
 - Any Alarms

- Status of the generator
- the necessary modules and memory to interface with the HMI, and provide it with historical data for displaying trends.
- with the necessary serial and binary ports to communicate with the following devices.
 - One Radar guided level sensor, transmitting continuous level readings via a serial protocol.
 - Three ball float switches
 - Four RF admittance level switches.
 - Twelve PT100 Thermal sensors at the Pump Motor windings and bearings
 - Three PT100 thermal sensors for the Screw lower bearing
 - Three Vibration sensors for the screw lower bearing

The definitive list of devices that require an interface to the PLC is tabled in PSE 11.5.

PSE 11.3 PLC: Memory Modules

The HMI shall display a running trend of selected parameters of the pump station. The memory storage shall be sufficient to store six months of all the readings listed in the following table. The readings are to be taken at 10-second intervals, with the peak reading in that 10-second cycle.

Device	Port Type
MCC: Energy Demand Meter (Mains Incomer)	kVA
MCC: Energy Demand Meter (Generator Incomer)	kVA
MCC: Pump 1: Pump Available and on Auto	Binary/In
MCC: Pump 1: Running/Stopped	Running Hours
MCC: Pump 1: VSD	RPM, kVA, kW
MCC: Pump 2: Pump Available and on Auto	Binary/In
MCC: Pump 2: Running/Stopped	Running Hours
MCC: Pump 2: VSD	RPM, kVA, kW
MCC: Pump 3: Pump Available and on Auto	Binary/In
MCC: Pump 3: Pump Trip	Binary/In
MCC: Pump 3: Running/Stopped	Running Hours
MCC: Pump 3: VSD	RPM, kVA, kW
SCREW PUMP: Pump 1: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 1: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 1: Motor Thermal winding/3	Analogue
SCREW PUMP: Pump 2: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 2: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 2: Motor Thermal winding/3	Analogue
SCREW PUMP: Pump 3: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 3: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 3: Motor Thermal winding/3	Analogue
SCREW PUMP: Pump 1: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 1: Screw lower bearing Vibration	Analogue
SCREW PUMP: Pump 2: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 2: Screw lower bearing Vibration	Analogue
SCREW PUMP: Pump 3: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 3: Screw lower bearing Vibration	Analogue

PSE 11.4 INPUTS AND OUTPUTS

The onus is on the Tenderer to study the Instrumentation and Equipment schedule in the following I/O Modules Schedule (PSE 11.5), as well as the proposed control philosophy described in section PSE 12, and thus determine the precise I/O requirements and provide the necessary I/O's with 20% spare capacity.

The modular system capabilities shall make it possible to add at least 50% additional I/O's in future without any need to increase the rack and cubicle size of the PLC.

PSE 11.5 I/O MODULE SCHEDULE

The Contractor shall supply and install Instrumentation, sensors and equipment interfaces for the following.

Device	Port Type
MCC: Energy Demand Meter (Mains Incomer)	Serial
MCC: Energy Demand Meter (Generator Incomer)	Serial
MCC: Pump 1: Pump Available and on Auto	Binary/In
MCC: Pump 1: Pump Off	Binary/In
MCC: Pump 1: Pump Trip	Binary/In
MCC: Pump 1: Running/Stopped	Binary/In
MCC: Pump 1: VSD	Serial
MCC: Pump 2: Pump Available and on Auto	Binary/In
MCC: Pump 1: Pump Off	Binary/In
MCC: Pump 2: Running/Stopped	Binary/In
MCC: Pump 2: VSD	Serial
MCC: Pump 3: Pump Available and on Auto	Binary/In
MCC: Pump 1: Pump Off	Binary/In
MCC: Pump 3: Pump Trip	Binary/In
MCC: Pump 3: Running/Stopped	Binary/In
MCC: Pump 3: VSD	Serial
MCC: ATS Generator Controller: Fault	Binary/In
PS: Float Switch (HHL)	Binary/In
PS: Float Switch (HL)	Binary/In
PS: Float Switch (LL)	Binary/In
PS: RF Admittance Level Sensor (Main Channel)	Binary/In
PS: RF Admittance Level Sensor (Pump 1 Well)	Binary/In
PS: RF Admittance Level Sensor (Pump 2 Well)	Binary/In
PS: RF Admittance Level Sensor (Pump 3 Well)	Binary/In
PS: Radar Level Sensor (Inlet Channel)	Analogue
SCREW PUMP: Pump 1: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 1: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 1: Motor Thermal winding/3	Analogue
SCREW PUMP: Pump 1: Motor Bearing	Binary/In
SCREW PUMP: Pump 2: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 2: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 2: Motor Thermal winding/3	Analogue
SCREW PUMP: Pump 2: Motor Bearing	Binary/In
SCREW PUMP: Pump 3: Motor Thermal winding/1	Analogue
SCREW PUMP: Pump 3: Motor Thermal winding/2	Analogue
SCREW PUMP: Pump 3: Motor Thermal winding/3	Analogue

SCREW PUMP: Pump 3: Motor Bearing	Binary/In
SCREW PUMP: Pump 1: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 1: Screw lower bearing Vibration	Analogue
SCREW PUMP: Pump 2: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 2: Screw lower bearing Vibration	Analogue
SCREW PUMP: Pump 3: Screw lower bearing thermal	Analogue
SCREW PUMP: Pump 3: Screw lower bearing Vibration	Analogue
MCC: Mains Fail	Binary
MCC: Generator Fail	Binary
MCC: Generator Fuel Low	Binary
MCC: Telemetry Outstation	Serial
MCC: HMI	Serial

PSE 11.6 INSTALLATION

The PLC shall be installed in a dedicated compartment of the MCC for the PLC and Instrumentation wiring. The I/O's shall be wired to terminal blocks in the marshalling section of the PLC panel.

The PLC and Instrumentation panel manufacturer shall adhere strictly to the recommended mounting and earthing requirements of the PLC manufacturer. The panel manufacturer shall confirm to the Engineer that the PLC will not at any time operate outside the environmental limits published by the manufacturer. The average maximum and minimum temperatures, the humidity as well as the heat dissipation of the PLC shall be taken into consideration when designing the compartment housing and apparatus

If forced ventilation and/or panel heaters are required to provide the climate necessary for the PLC apparatus, then this shall be included in the panel design, together with the climate monitors to inform the operator in the control room when the equipment is operating in undesirable conditions. Detectors shall be provided and wired to an input card of the local PLC to alert the operator via the alarm panel if the "climate" drifts outside the pre-set value.

PSE 12 Process Control and Automation: General

The Contractor shall program the PLC to operate the pump station autonomously, with little requirement for human intervention. In conjunction with the day-to-day operation of the pump station, the PLC shall monitor the condition of the pumps, and the pump station in general, and alert the WWTW of an alarm condition.

PSE 12.1 Process Control and Automation: Control Philosophy

The pumps and equipment that will be managed and controlled by the PLC are as follows:

- Main pumps: 3 No 100 kW absorbed power max (130 kVA motor) – 2 duty and 1 standby
- The screw pumps are operated by VSDs, as indicated in the single line diagrams issued with this tender. The screw pumps respond to the feedback from the Radar Level detector in the inlet channel, as directed by the PLC.

Operation: Level and VSD controlled

- When a Pump selector switch is in AUTO, the pump is available to be controlled by the PLC.
- The PLC communicates directly with each VSD via a serial channel. This means that a pump is started by a command that is delivered via the serial port. The PLC shall also modulate the speed of the pump by sending commands over the same serial channel. Information, such as power and amperage, is also exchanged over this same channel.

- The PLC shall decide which pumps are to be switched into operation. The PLC shall take into account the number of available AUTO pumps online, the accumulated running hours of each of the motors, and number of starts experienced by the available pumps when deciding which pump to select for duty.
- The PLC shall control the pump station by matching the liquid level reading.
- The following strategy describes the normal mode of operation for the pump station.
- As the inlet channel level increases above the lead pump start level, the lead pump starts and is ramped by the VSD up to the Minimum Operating Speed.
- The PLC then increases the speed of the pump to the Minimum Efficient Speed.
- As the well level increases, the speed of the pump increases linearly from the Minimum Efficient Speed to the Maximum Speed of the pump.
- At the lag pump start level, after a short delay, the lag pump shall start.
- The lag pump is ramped up to the Minimum Operating Speed.
- The PLC then increases the speed of the lag pump while decreasing the speed of the lead pump until the speed of both pumps are the same.
- Once reaching this level, the pump speed shall adjust linearly between the lag pump start level, and the lead pump start level.
- The speed set point shall be calculated for each pump by the following general equation.
 $y = mx + b$ where y = speed set point, x = current liquid level $m = (\text{lag pump start level} - \text{lead pump start level}) / (\text{Maximum pump speed} - \text{Minimum Efficient Speed})$, $b = (\text{Minimum Efficient Speed} - \text{Minimum Operating Speed}) / (\text{Maximum pump speed} - \text{Minimum Operating Speed})$
- If a duty pumps fails to start, the standby pump shall be called to start.

Generator and Maximum Demand:

- The PLC shall continually monitor the real time demand of the pump station. The PLC shall ensure that the loads do not exceed the capacity of the Mains or the Generator (when supplied by the Generator).
- On sensing of a power failure, the generator shall start and the MCC incomer is transferred to the generator supply.
- Once mains returns, the generator shall be synchronised to the mains frequency and phase, and then the two incomers are coupled together momentarily, before the incomer is completely transferred over to the mains supply. This ensures a seamless transition from generator supply to mains supply.

Alarms:

- The PLC shall communicate any alarms to the Telemetry outstation for onward transmission.

PSE 13 HMI: General

A graphical human machine interface (HMI) shall be provided and mounted inside the MCC and shall be configured to provide the operator with control system parameter adjustments, status information, current alarm lists and real time short-term graphical trends.

The HMI shall allow control parameter changes to the PLC which shall be password protected.

Operator actions, selections or setting described in the control philosophy shall also be possible via the HMI Interface (and via the SCADA in case of the HMI not being available).

PSE 13.1 HMI: Equipment

- | | |
|-----------------------|--|
| • Type | Colour LCD Display, 266 colours |
| • Resolution (Pixels) | 800 x 600 |
| • Backlight | CFL (60000hrs at 25deg C and 24hr operation) |

- Touch Panel / Screen (40 x 30 screen grid)
- Memory (Flash EPROM) 8 Mbyte or better
- Data Backup (SRAM) 612 kilobyte or better
- Interfaces Protocol Serial (11.5 kbps), Ethernet IEEE802.3
- Interface Port SUB-DP, RJ45 respectively
- Sound (for Alarm) Built in or separate speaker / buzzer
- Data Transfer Via USB Memory Stick
- Operating System Propriety Graphic Interface

The HMI shall be configured with a simple default WWTW graphic display (mimic) showing all pertinent equipment, its status (running, tripped or stopped) and instantaneous instrument readings.

Mode selection on the MCC and related electrical devices shall be clearly, indicated on the HMI. The HMI itself is not intended to be used for operation of any equipment (i.e. starting or stopping).

A navigation screen shall be provided from where the operator can navigate from the overview to detailed screens for the pump sets, the screening plant, the odour control plant, the reactor and the standby generator.

Status shall be indicated by different state colours (such as white for ready, green for running, amber for tripped and red for 'E-stop' or other fault states).

A trending page shall be provided showing all instantaneous measured value readings. Trends shall be configured to show an interval of readings suitable for the rate of change of the actual process value.

An alarm page shall be provided showing all current alarms. Alarms shall also be stored in a first in first out file stored in the HMI memory. It shall be possible to scroll backward and forward in the alarm list.

PSE 14 Field Equipment Boxes (FEB)

The FEBs are required for the connection of the field C&I transducer.

The FEB shall be of Stainless Steel.

The FEB shall be equipped with a removable chassis plate upon which the field instrumentation equipment including surge arrestors etc. shall be mounted.

The front door of the FEB shall be a hinged door with an armour plate glass window mounted in a rubber seal. The equipment mounted in the FEB shall be located such that the display can be read without opening the door. The door shall be fitted with a lockable latch.

The FEB shall be equipped with removable, bottom entry, gland plates. All cabling to and from the equipment mounted in the FEB shall be glanded off on these gland plates.

Power and signal cable cores shall be terminated on rail mounted surge arrestors mounted in the FEB.

The FEBs shall be numbered using white / Black / White traffolite labels with 10 mm high lettering. Each FEB shall carry a five digit number - being the number of the transmitter housed therein.

A prototype of the FEB proposed shall be submitted to the Engineer for approval before purchasing.

FEB's shall contain the lightning arrestors for the power and signal cables to the field mounted instrument transmitters.

PSE 15 Lightning Surge Arrestors

Surge arrestors installed in MCCs shall be equal or similar to the ASCO series 510-240 individual 120 kA single pole devices. Installation shall be as per the manufacturer's installation specifications.

Surge arrestors for the small power sub distribution board shall be equal or similar to the ASCO 450-230Y40 type with a 40 kA rating.

Each core (excluding the earth core) of the instrumentation signal and power cables shall be terminated at each end on a lightning surge arrestor.

The terminal strips in the Marshalling Cubicles shall be fitted with the arrestors.

The arrestors to be fitted in the FEBs shall be Phoenix or similar approved for power and signal line protection.

PSE 16 Instrumentation and Cabling

Instrumentation power cabling shall be PVC/SWA/PVC.

Instrumentation signal cabling shall be PVC/SWA/PVC overall screened, Dekoron type M875 or similar approved. All instrument, power and signal cabling shall have flexible stranded cores 1.5 mm' total cross section made up of a minimum of 24 strands of copper wire.

Instrument, power and signal cabling for equipment Installed in submersible and submersible chambers shall be suitable for installation in submersible conditions. All terminations and glands shall maintain an IP67 rating.

The motor terminal box sensor and thermistors for shall be wired to a terminal strip in the motor terminal box. A 6 pair cable shall be used for connecting the sensors to the MCC.

Three thermistors (one per phase) shall be installed in the pump motor.

PSE 17 Local Stations (E-Stop)

One Local station, complete with bracket, shall be supplied and installed for each screw pump. The station shall provide the following feature:

- Local Isolator
- Emergency Stop Button

Connection for motor winding heater

- Connection for Motor winding thermistors

PSE 18 Tests

After completion of the works and before first delivery is taken, a full test shall be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installations shall be inspected and the Contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.

The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installations at completion.

PSE 19 Maintenance of Installations

With effect from the date of the First Delivery Certificate the Contractor shall at his own expense undertake the regular servicing of the installation during the maintenance period and shall make all adjustments necessary for the correct operation thereof.

If during the said period the installations is not in working order for any reason for which the Contractor is responsible, or if the installations develops defects, he shall immediately upon being notified thereof take steps to remedy the defects and make any necessary adjustments.

Should such stoppages however be so frequent as to become troublesome, or should the installations otherwise prove unsatisfactory during the said period the Contractor shall, if called upon by the Engineer/Employer or the Director-General, at his own expense replace the whole of the installations or such parts thereof as the Engineer/Employer or the Director-General may deem necessary with apparatus specified by the Engineer/Employer.

PSE 20 Regulations

The installation shall be erected and tested in accordance with the Acts and Regulations as indicated in the scope of works

PSE 21 Earthing on Installation

Main earthing

The Main earth shall be derived from the Miniature substation, installed by the Contractor.

PSE 22 Schedule of Luminaires

The light fittings and accessories are to be according to the Bill of Material.

PSE 23 Schedule of Cables, Conduit and Wiring

Supply, install and connect the cable, conduit and wiring as per a Bill of Material.

MCC MOTOR CONTROL CENTRE

MCC 1 SCOPE

This specification covers the general technical requirements and the standards of equipment and materials in the design of Low Voltage Motor Control Centre (MCCs), where the voltage does not exceed 400 volts.

MCC 2 REFERENCE

The construction of MCCs and the equipment therein, shall comply with the latest revisions and amendments of the relevant SANS, IEC and British Standards except that should any conflict occur, the requirements of this specification shall apply.

MCC 3 GENERAL

The design, construction and layout of MCCs shall comply fully with the requirements of this specification and of Section PSE of the Particular Specifications and or schematic drawings issued.

Where conflict occurs, the requirements of Section PSE of the Particular Specifications shall take precedence, followed by the requirements indicated on the drawings.

Each MCC shall be provided with an incoming feeder capable of carrying the connected load of the MCC, and each MCC shall be fully interlocked in the starting and tripping sequences.

The General Arrangements of each MCC and of a typical cubicle showing the equipment layout shall be approved by the Engineer, in writing, prior to manufacture, and all MCCs shall be inspected by the Engineer before delivery to site.

The Tenderer shall submit the following information with his Tender'

- General Arrangement drawings of each MCC, showing the internal equipment layouts, foundation details and approximate weight. All major dimensions shall be in millimetres.
- A schedule indicating the manufacture, type and rating of all the equipment being offered.

MCCs shall be so constructed that they may be split into smaller sections suitable for transportation, with each section being provided with eyebolts for lifting purposes.

MCC 4 ENCLOSURE

Motor control centres shall be the product of specialist manufacturers of this type of equipment.

They shall be floor standing, bottom or top entry as specified in Section PSE of the Particular Specifications. Dust, damp and vermin proof, multi-tier, industrial pattern and of multi-section construction. They shall be of folded heavy gauge sheet steel design, with a recessed plinth of channel or heavy gauge sheet steel angle section, the construction being such that the rigidity of the frame, doors and rear covers is adequate.

Sheet steel used in the construction of MCCs shall be a minimum of 2 mm thickness, folded and braced as necessary to provide a rigid support for all components. Joints of any kind in steel metal work shall be seam welded, and all welding slag ground off and welding pits wiped clean with plumber's metal.

All panel doors and covers shall be properly fitted and square within the frames. Holes in panels for fixing screws shall be accurately positioned to allow entry of screws without distortion of the panels. Only fixing screws of the correct length shall be used, the cutting to length of any screw once installed is not acceptable.

All cover fixings shall be by means of captive screws. Dome nuts are not acceptable. Sheet steel may be drilled and tapped to take fixing screws up to 6 mm diameter. For screws or bolts of larger diameter, hank nuts shall be used. Self-threading screws shall not be used in the construction of these boards.

After fabrication is complete, all metal work shall be de-rusted, degreased and painted inside and out with at least one coat of metal primer and two coats of epoxy based enamel. The interiors shall be finished white and the exterior shall be light orange (colour ref. 826 to SA8S 1091).

All doors and removable covers shall be rendered dust proof by means of suitable seals fixed to the frame. The IP rating of new MCCs shall be IP55.

MCC 5 LAYOUT OF EQUIPMENT

The MCCs shall be carefully laid out ensuring ample space for wiring and components giving due consideration to accessibility and operational efficiency and the making-off of incoming and outgoing cables. A minimum of 300 mm clear vertical space shall be allowed between the gland plate and any terminal block. The distance between the wiring channel and any terminal to which the wires from that channel are being made-off, shall not be less than 75 mm.

The equipment shall be arranged within boards to exhibit a neat appearance, with all items of equipment and their labels, mounted level and plumb. Any label shall be mounted on the centre lines of its associated equipment, in an unambiguous position. Each motor drive shall be housed in a separate cubicle, except where there may be an abundance of fractional kW motors, and therefore for optimum space utilisation, multiple drives are acceptable in a single cubicle. The labelling of these cubicles shall be in accordance with paragraph MCC 16.

Each tier and each cubicle shall be physically isolated from the adjacent tier or cubicle.

All cubicle equipment shall be mounted on a removable rigid sheet steel chassis plate, bolted to the supporting frame. Chassis plates shall be so designed as to facilitate easy removal or replacement. All control wiring and wiring external to the chassis, shall terminate on to a single terminal block mounted on the chassis plate. No wiring shall be connected to equipment on the chassis other than via the terminal block.

The layout of all equipment on the chassis plate shall be arranged so that any item of equipment, or any connection to an item of equipment, may be removed and or replaced with

the chassis in situ. The side of any piece of equipment to which connections are made, shall not be closer than 50 mm to the vertical or horizontal partitions.

The layout of chassis plates for each size of cubicle shall be identical to allow for the quick interchange of chassis plates.

All power connections shall terminate onto suitably rated terminals, situated not less than 300 mm and not more than 450 mm above the gland plate and located in the cabling compartment so as to allow easy access to all terminations, even after the installation of all cables

Where it is possible for personnel to touch live components with the cubicle door open, these components shall be disconnected from the supply before the door can be opened. This shall be achieved by installing a disconnecter, operated via a "varidepth" handle fitted to the cubicle door, so that the door can only be opened when the disconnecter is in the "off position". It shall not be possible to close the disconnecter when the cubicle door is open.

Spare cubicles shall be equipped with all necessary connections, terminals, and other fixed accessories to facilitate their future use. Contactors, MCB's and controls however shall not be fitted. The blank door shall be labelled "Spare".

MCC 6 BUSBARS

Busbars shall be of high conductivity hard drawn copper, of rectangular and uniform cross-section supported on suitably sized insulators. Busbars and down droppers on all 400 volt MCCs, shall be rated in accordance with the recommendations of the Copper Development Association, and to withstand the stresses associated with the fault level called for on the Drawings, for one second duration.

The busbars and down droppers shall be screened to prevent accidental contact when the rear covers are removed. Where this is impractical they shall be completely insulated by means of PVC sleeving or tape. Busbars and down droppers shall be phase colour coded, and spaced at not less than 25 mm phase to phase, and 20 mm phase to earth, for a 400 volt supply.

Busbars shall be joined together by bolted overlaps, the bolt arrangements shall be those recommended by the Copper Development Association. Bolts used for jointing and for fixing take-offs, shall be of high tensile phosphor bronze not less than 9,5 mm in diameter. All bolts shall be provided with wide flat washers at each end, and with spring washers under the nuts. Busbar supports shall be of glazed porcelain or glass fibre reinforced polyester. Spacers where required shall be of "Tufnel" or equivalent.

The spacing of bus bar supports shall be adequate for the MVA rating of the MCC.

Multiple busbars shall be arranged with air gaps between individual sections, equal to the section thickness.

Busbar extensions shall be provided on the incoming circuit breaker to facilitate the connections of the incoming cables, and to act as a heat sink in dissipating the heat generated internally, and at the terminals of the circuit breaker.

MCC 7 WIRING AND TERMINALS

All motor control centres shall be pre-wired in the factory to terminal blocks installed in the cabling compartment of each starter unit and marshalling cubicle. Access to the terminal blocks in the starter cubicle shall be gained by removal of the cable compartment cover. With the exception of the terminal blocks, no live parts shall be accessible.

Wiring channels shall be provided in all boards, running both horizontally and vertically, and of sufficient capacity for all main and sub circuit wiring. Internal wiring run via slotted plastic trunking shall not occupy more than 50 % of the trunking cross sectional area.

All secondary wiring between the various units of the MCC shall be provided using 600/1000 volt grade, PVC insulated stranded copper conductor, of minimum size 1,5 mm². The wiring shall be run neatly and harnessed with an approved strapping and secured to substantial supports. A suitable strain relieving clamp system shall be provided on both the panel and door side of the harness.

Compression crimp type terminations shall be used for all wiring connections to instruments, relays and other devices. Where clamp type terminals are provided pin type ferrules shall be used. Spade or "C" type lugs shall be used elsewhere.

All crimping shall be done with the maker's special tools which shall not release until the full crimping pressure has been achieved. The ends of the conductors of 50 mm² cross-sectional area and upwards shall be crimped by hydraulic machine.

Wiring shall be provided with a neoprene sleeve or ferrule at each end indicating the respective wire numbers. All cable and wire markers shall be so positioned that positive identification can be achieved without the need for manual adjustment or alignment. Split type ferrules shall not be accepted.

Where an MCC is to be split for transportation, the wiring shall be continuous with the wires being disconnected at the relevant terminal blocks and rolled back.

Terminal blocks shall be used for conductors up to 10 mm² only, and shall be of nylon construction, flexible to avoid damage to screw holes, and clamped to rolled metal sections allowing for the addition or movement of terminal units. The terminal screws shall be of tinned non-ferrous metal, captive in the blocks, and shall operate through serrated copper clamping washers onto the conductors. Terminal blocks shall be similar and equal to "Klippon" type SAK series.

Short circuiting type terminal blocks shall be fitted for all current transformer secondary leads.

Where the cross-sectional area of conductors differs considerably, the terminal strips shall be provided with a suitable proportion of the correctly sized terminal ways. No strands shall be cut from the larger conductors to permit termination into an undersized terminal. No more than one conductor shall be connected to anyone terminal and if several conductors are to be combined this shall be achieved by means of bridging pieces on the terminal strip.

No isolating link type terminals shall be used for motor or earth connections.

Ample space shall be provided for incoming and outgoing cable tails and for access to cable terminations.

Terminal blocks shall be formed with channels to accept snap-in plastic labels bearing the circuit designations, and all terminal blocks shall be clearly identified with the terminals being numbered from the top in descending order.

Connection diagrams shall indicate the connection numbers, and terminal numbers.

MCC 8 COMPONENTS

Indicating instruments shall be flush panel instruments to BS 89, of first grade accuracy, With not less than 96 mm dials. Current transformers shall be to BS 3938, of suitable grade and burden in each case.

Where a current transformer serves also for metering purposes it shall be of Class 1. Current transformers shall be so mounted as to ensure adequate ventilation and easy replacement. A duplicate transformer nameplate label shall be fixed to the chassis plate should the current transformer label be obscured from the front.

Hours run meters shall be provided where called for on the drawings. These shall be 48 mm square, flush mounted, operating on 220 volts, 50Hz, with a minimum capacity 999999 hours. A key operated reset shall be a standard feature.

LED cluster lamps are preferred for indicating lamps in place of filament lamps.

MCC 9 CONTROL VOLTAGE

The control voltage shall be 230 volts AC, single phase. This 230 volt supply shall be provided from the red phase and neutral and shall be protected by a double pole moulded case circuit breaker or as indicated in the relevant schematic diagram.

MCC 10 INCOMING FEEDERS (GENERATOR & NORMAL)

A separate cubicle shall be provided in each MCC to accommodate the Main Incoming Feeders. This shall comprise circuit breakers suitably rated; incorporating a manually operated spring assisted closing mechanism, shunt trip coil, thermal overcurrent and instantaneous short circuit tripping devices with facilities for padlocking in the "off" position.

The live side of the circuit breakers shall be suitably screened to ensure that no live conductors are exposed when the panel cover is removed.

The following shall also be provided for each feeder:

- One 96 mm flush fitting voltmeter, scaled 0 to 450 volts, and connected to the busbar side of the circuit breaker.
- One set of HRC fuses for voltmeter protection.
- Three 96 mm flush fitting, thermal maximum demand ammeters, suitably scaled Three current transformers for ammeter operation
- One set of main circuit labels and drilled cable glands to accommodate the cables detailed in the schedules, if applicable.

Test blocks for current and voltage circuits with inherent current transformer short circuiting features shall be provided on all incoming feeders.

MCC 11 BASIC DOL MOTOR STARTER

The basic D.O.L motor starter cubicles shall be equipped as follows. The final details and ratings of equipment shall be given on the schematic diagrams.

One triple pole moulded case circuit breaker, as specified, capable of interrupting the maximum through fault current. The circuit breaker shall be operated by a "varidepth" handle, pad lockable in the "off" position, and having a safety interlock so that the compartment door may only be opened when the circuit breaker is in the "off position. The circuit breaker shall also be equipped with an auxiliary switch to isolate the control supply within the cubicle when the circuit breaker is opened.

One triple pole, air break, heavy duty contactor with inherent under voltage release feature and fitted with auxiliary contacts as indicated in the typical schematic diagram. One triple pole, combined thermal overload and differential action single phasing protection relay, equipped with hand reset feature. The relay shall be equipped with double break normally open and normally closed auxiliary contacts for interlocking and indication purposes.

Thermal overload units shall only be used for starters rated at up to 55 kW. Starters rated at 55 kW and over, shall be equipped with a Sprecher & Schuh type CET relay or equivalent.

The following controls shall be fitted to the panel door:

- One 96 mm flush fitting, suitably scaled, direct or current transformer operated ammeter.
- One current transformer for ammeter operation shall be provided where the rating of the circuit exceeds 25 amperes.
- One rotary type change over switch, "Manual/Auto" One amber "Overload Trip" indicator lamp
- One green "Run" indicator lamp
- One red "Stop" indicator lamp
- One running hour meter

Earth leakage protection shall be provided by means of a 250 mA instantaneous earth leakage protection relay with core balance transformer and hand reset relay.

MCC 12 OUTGOING FEEDERS

One triple pole moulded case circuit breaker with thermal and magnetic overcurrent protection, capable of interrupting the maximum through fault current. The circuit breaker shall be operated by a "varidepth" handle, pad lockable in the "off" position, and having a safety interlock so that the compartment door may only be opened when the circuit breaker is in the "off" position.

One 96 mm flush fitting, direct or current transformer operated ammeter suitably scaled.

One current transformer for ammeter operation. To be provided where the rating of the circuit exceeds 25 amperes.

If required, earth leakage protection shall be provided by means of a 250 mA instantaneous earth leakage protection relay with core balance transformer and hand reset relay.

MCC 13 MARSHALLING CUBICLE

A marshalling cubicle shall be provided in each MCC, all "hard wire" field and starter interlocking control shall be done via the marshalling cubicle, which shall also house all interposing relays.

MCC 14 CABLING

Cables shall be top or bottom entry as called for in Section PSE of the Particular Specifications. A common gland plate shall be located in each cubicle to allow for easy installation of both glands and connections to the terminals.

MCC 15 EARTHING

Each cubicle in the MCC shall be provided with an earthing stud connected directly to the MCC earth bar. This main earth bar shall be copper with a minimum cross-section of 20 mm x 6 mm, running the entire length of the MCC and be complete with two terminal studs, one at each end for connection to the main earthing system.

MCC 16 PANEL NUMBERING AND LABELS

The tiers on each MCC shall be numbered consecutively from left to right, when facing the front of the MCC. The cubicles in each tier shall then be allocated consecutive letters of the alphabet,

starting with the letter A and reading from top to bottom. Each letter shall be prefixed with the tier number.

The top of each rear access cover shall be clearly labelled with the tier number.

Each cubicle shall be fitted with a circuit designation label on its front cover.

In addition to the identifying label mounted on the front panel for each starter cubicle, a similar label shall be mounted at the rear of each cubicle to be visible when the rear covers are removed and shall indicate the tier number, cubicle letter and the circuit designation.

Components such as circuit breakers, isolators, indicating lamps, switches, relays, Instruments, test blocks, fuses, etc." shall be clearly identified with engraved labels indicating their function,

Where a multiple drive cubicle is supplied, a label listing all the drives in that cubicle shall be provided on the door of that cubicle

Labels shall be of plastic "sandwich" board material, the legends being engraved through the front layer to the contrasting inner layer, The lettering shall not be less than 6 mm high in sans-serif capitals, black lettering on a white background shall be selected to ensure maximum legibility, All labels shall be secured by at least two bolts, or rivets per label, and shall be accurately level and on the centre line of their subjects,

Glued labels, adhesive embossed plastic tape or paper labels are not acceptable,

All label inscriptions shall be in English, and all label designation lists shall be approved by the Engineer prior to engraving.

MCC 17 INSPECTION AND TESTING

All MCCs shall be inspected by the Engineer or his representative, when fully assembled and complete with all equipment, prior to despatch from the suppliers' works,

The following tests shall be required, at the Inspectors' discretion, prior to despatch from the suppliers' works:

- High Voltage pressure tests
- Primary current injection tests of all protection relays
- "Megger" insulation tests
- Complete functional and operational tests.

MCC 18 DELIVERY AND ERECTION

The Contractor shall be responsible for the delivery to site, off-loading, erection and cold commissioning of all the MCCs.

EAA LOW VOLTAGE SWITCHBOARDS

EAA 1 GENERAL

The switchboard(s) shall comply with BS 5486, IEC 439, the Occupational Health and Safety Act of 1993, and local authority's requirements. Switchboards shall be floor or wall mounting type with front access or free standing with front and/or rear access, as specified.

The switchboard(s) shall be dustproof, vermin proof and adequately ventilated to prevent overheating of the equipment.

Drawings of the switchboard(s) shall be submitted to the Engineer for approval prior to manufacture.

Surface mounted cartridge type fuses for instrument protection, as specified, shall be mounted on the busbars.

Current transformers (ratio and burden as specified) shall be of the pedestal type or as noted, and shall be securely mounted in the switchboard.

The completed switchboard(s) may be inspected by the Engineer at the manufacturer's works prior to despatch. The Contractor shall inform the Engineer timeously in writing when the switchboard(s) is ready for inspection.

EAA 2 CONSTRUCTION

The switchboard(s) shall be of robust construction consisting, in general, of a channel, box or angle iron frame covered with sheet steel panel(s) of 1.6 mm minimum thickness.

The panel(s) shall be reinforced to prevent distortion and to ensure rigidity. The electrical equipment shall be flush mounted on a chassis within the switchboard. The panel shall be suitably slotted or drilled to allow the operating handles of the switchgear to protrude.

Removable panels shall be provided for access to the wiring, busbars and equipment. The panels shall be held in position by chromium plated coin slot square key or knurled captive thumb screws. Switchboards shall have lockable doors where specified.

Space for 50% spare ways, unless otherwise noted, shall be allowed on the switchboard for future equipment. Each spare outgoing way shall include sufficient space for future switchgear and associated instrumentation, similar to the equipped outgoing ways.

All drilling, cutting or any other metalworking operations shall be completed prior to any paint process being undertaken.

Prior to painting, all metal parts shall be prepared to SANS 064 clause 6.22 for high quality - finished commodities; medium weight phosphating may be employed.

In the period 24 - 96 hours after phosphating, a high quality zinc-chromate primer to SANS 679, Type 1, shall be applied, followed by two coats of high quality alkyd based enamel to SANS 630. Care shall be taken to cover all edges properly.

The paint to be used shall have an impact resistance of 9 kg on a 9 mm mild steel plate and a scratch resistance of 1000 grams.

After baking, the minimum film thickness of the paint shall not be less than 0.06 mm. The switchboards shall be finished in the colour specified on the outside and white on the inside.

EAA 3 BUSBARS

Aluminium and copper busbars shall have joints of adequate contact area for the current rating and to prevent joint relaxation by cold flow of the metal. Spring washers shall be used when bolting joints.

All joints in the busbars shall be firmly bolted together with suitable high tensile steel bolts and nuts. Spring washers shall be used.

Bolted joints shall be designed to maintain contact pressure permitting rated current at rated temperature and thermal expansion without buckling of busbars. Joints shall not loosen under vibration. Joints on aluminium busbars shall be suitably prepared.

The manufacturer shall specify the tightening torque to be applied to bolted joints in busbars.

All busbars shall be carried on insulated supports placed at intervals not exceeding 600 mm for main busbars, or 300 mm for busbars droppers. They shall be adequately identified in phase colours. Connections to busbars shall be made by means of bolted take-offs.

Busbar insulator material shall be Tufnol of suitable grade, or equivalent, shaped and spaced to provide protection against tracking, flashover or distortion of busbars.

The insulators shall be tested in accordance with SANS 161.

The moisture absorption resistance shall be in accordance with SANS 161.

Incoming and outgoing busbar stubs, where required, shall be suitably insulated where they pass through the top panels of the switch board and shall be suitably and firmly supported within the board.

Incoming and outgoing collector bars for cables in parallel shall be so arranged that the multiple cable ends can be connected to the collector bars with reasonably short tails to eliminate crossing of conductors.

Busbar droppers to and from circuit breakers shall not be supported only by the circuit breaker terminals (or the circuit breaker cradle terminals) and the main bus bars, but shall also have a suitable intermediate insulated support. Heavy out going cables shall be supported so that there is no undue strain on circuit breaker or circuit breaker cradle terminals.

Where stub bars are used to accommodate large cable ends at the circuit breaker terminals, the Contractor shall ensure that the clearance between phases is adequate.

EAA 4 SWITCHGEAR GENERAL

All switchgear shall be flush mounted behind removable panels with operating handles only projecting through suitable machine punched slots or holes.

Equipment of normally surface-mounted types such as energy meters, time switches and relays, shall be mounted on suitable chassis behind hinged front panels. In the case of inserts to facilitate reading the meter.

EEA 5 EARTHBAR

Each board shall be equipped with a copper earth bar of sufficient length to allow for the termination of all the incoming and outgoing earth conductors. The size of the earth bar to be as noted on the drawings. The earth bar shall be complete with adequate brass bolts and nuts.

EAA 6 CABLE ENTRIES AND TERMINATIONS

Cable gland plates shall be galvanised and of at least 3 mm thickness. The gland plate shall be bonded to the main earth bar with a copper earth strap having a cross-sectional area equivalent to that of the earth bar.

When cables enter the top of the board a similar cable gland plate shall be incorporated in the top of the switchboard and shall be connected to the main earth bar in a similar manner. Spare entry holes in the top gland plates shall be provided with galvanised blank seals.

Gland plates and cable end support bars must be placed at suitable heights having regard to the bending radii of the cables concerned and convenience in making off. The support bars should preferably be of a section similar to "Unistrut" and be fitted with sliding clamping bolts.

The entire board shall be vermin proof, and at the gland plate the vermin-proofing shall consist of expanded metal of a suitable gauge secured to the gland plate and the framework of the board.

EAA 7 WIRING

All internal wiring shall be laced or run in wiring channels and shall be clearly marked with numbered ferrules and colour coded.

Stranded wire shall be used having a minimum area of cross-section of 2.5mm² and shall comply with SANS 150.

Where circuit breaker terminals are designed to take stranded conductors, PVC insulated stranded conductors shall be used. The jumpers to each breaker shall be separately run and the individual conductors in each set separated from each other by a spreader secured to the conductor to prevent movement during fault conditions and to maintain conductor spacing.

All equipment shall be clearly labelled as specified. The labels shall be of Ivorine or plastic secured by screws or rivets.

EAA 8 LABELLING

All switchboards shall be labelled as specified. Glass- or clear perspex- covered, framed legends shall be fixed to the boards or adjacent thereto.

All fuse-switches, circuit breakers and other apparatus on switchboards shall be labelled to indicate their function.

The incoming isolating switch or circuit breaker on each board shall be labelled "Main Switch". 10 mm high letters shall be provided on each switchboard indicating voltage present. All labels shall be in English.

All masking tape and other temporary markings are to be removed on completion of the installation work.

The Contractor shall provide separate diagrammatic charts showing essential features of the as-installed electrical system, including single line and riser diagrams on which equipment designation shall correspond with labels.

EAA 9 NOTICES

The following notices in compliance with the Occupational Health and Safety Act of 1993, in English, shall be supplied and installed by the Contractor.

- Notice prohibiting unauthorised persons from entering the switch room or substation.
- Notice prohibiting unauthorised persons from handling or interfering with electrical apparatus.
- Notice containing directions as to procedure in case of fire.
- Notice containing directions as to restoration of persons suffering from the effects of electric shock.
- Danger notices (skull and crossbones).

The notices defined above shall be mounted on the outside of the switchroom/substation door(s).

All other notices shall be mounted in a conspicuous position inside the switchroom/substation.

The notices shall comprise black embossed letters, at least 15 mm high, on a yellow backplate.

EAA 10 GUARANTEE

The tenderer shall give guarantee to replace free of charge any parts of the low voltage switchboard 'In which manufacturing defects may develop during the Defects Notification Period.

TLT TELEMETRY

TLT 1 SCOPE

This specification covers the specification of the data capture and communication equipment required in the Telemetry System.

Aspects covered are:

- The Control, Input and Output Modules. Power Source and Enclosures.
- The Communication Media and Equipment. Surge Protection
- Data Protocols.
- The System Modes of Operation. Documentation, Commissioning and Training

TLT 2 HARDWARE ORGANISATION

General

Only systems designed specifically for radio-based tele-control shall be considered for this project. Systems designed for network or twisted pair linkup and adapted for radio communications shall not be accepted for this project. The use of a personal computer as a station controller shall not be considered,

A telemetry station shall consist of one CPU Module, selected Input and Output Modules, a power supply and a communications system, together in a cabinet. The CPU Module shall be equipped with a CPU watchdog timer circuit that shall automatically restart the system in case of severe electrical disturbance.

The telemetry CPU Module shall be auto-configuring. It shall determine automatically which I/O module is connected, data addressing, and mode of operation to run. It shall not be necessary to use a programmer/lap-top/PC to setup any outstation.

Physical Layout

The CPU and I/O Modules shall be mounted on standard DIN-rail. Rack-mounted modules that use high-density connectors onto a back-plane shall not be accepted for this project. The radio, power supply/charger and batteries shall be securely fixed with brackets to the inside of the cabinet. The radio shall connect to the CPU Module via a robust connector and a wiring harness.

The I/O Modules shall connect to the CPU Module by ribbon cable in 'daisy chain' fashion. High quality connectors with eject latches and strain relief for reliability shall be used. Input and Output connections to the I/O Modules shall be via robust plug-in screw termination strip. The I/O Module shall be able to be unplugged and removed without unscrewing the field wiring. The PCB connectors shall be shrouded to ensure that they cannot be misaligned when plugged in.

Barrier Modules shall be used to provide additional buffering or signal conditioning for the 110 Modules. These modules shall be separate, field replaceable items. They shall mount onto standard DIN-rail. Wire connections to the Barrier Modules shall use the same type plug-in screw terminations as the I/O Modules.

I/O Signal Lines

Digital Status Input (for "dry contact" sensing) shall be active low, and protected for accidental voltage input of up to 24 VDC. Cable lengths of up to 20 m unscreened and 100 m screened shall be accommodated. Optional barrier modules shall provide further signal buffering.

Digital Status Inputs (for opto-isolation) shall be able to accept input of any polarity from external power source of 12, 24, 36, 50 or 110 VDC. Isolation shall be rated at 1500 VAC and 1000 VDC continuous.

Digital (Control) Output lines shall be active low, open collector transistors with a rating of 27 VDC (OFF) and 200 mA current sink (ON). Suitable protection shall be provided on the Module to protect the output transistors if relay coils are driven from the Digital Outputs.

Relays on control outputs shall have contact rating of 8 A at 240 VAC. These shall be included as buffering for digital outputs where necessary.

Analog Input lines shall accommodate 0 - 5 VDC, 0 - 10 VDC, 0 - 20 mA or 4 - 20 mA input signals. This may be achieved directly by the I/O Module, or via separate barrier modules. The resolution shall be 0.5 % (8 bit) or 0.1% (12 bit) bit. The 12 bit option shall have differential inputs (no common ground) with common mode voltage rejection of 20 VDC.

Analog Output lines shall similarly accommodate 0 - 5 VDC, 0 - 10 VDC, 0 - 20 mA or 4 - 20 mA output signals. The choice of output signal shall be independent of the choice of corresponding input signal. The output accuracy shall be better than 0.5 % (8 bit) or 0.1 % (12 bit).

Counter Inputs shall be suitable for accumulating up to 65000 pulses (16 bits) at the outstation, at a rate of up to 50 pulses per second. Input shall be suitable for either semiconductor switch (e.g. open collector/drain from flow measuring device) or dry contact.

Serial (RS 232) Interface

The telemetry system shall be able to be interfaced to a Personal Computer, PLC, local controller etc. This shall be achieved via standard RS232 hardware link. The RS232 serial port shall be able to operate at 300, 1200, 2400, 9600 or 19200 baud. Handshake protocol should include XOn/XOff, CTS/RTS and none (direct).

Power Supply

Power from a number of sources must be able to be used to power a telemetry station. These shall usually be one of the following:

Mains Only: An industrial type power supply shall be used to provide 13.8 VDC for the station. The power supply output shall be rated at 50 % greater than the peak required by the system.

Mains with Battery Backup: A battery shall be chosen to suit the backup time required with the calculated static load. A fully operational backup time of 8 hours is required unless otherwise specified. The charger shall be rated to completely recharge the battery within 10 hours while delivering the static load.

Battery Choice

Batteries less than 15 Ah capacity shall not be used due to the high peak discharge current during radio transmission. Nickel Cadmium batteries shall not be used. Sealed, gel type lead-acid batteries shall be used for capacities up to 65 Ah and may be housed in the same enclosure as the telemetry equipment. Vented lead-acid storage cells designed for standby applications shall be used for larger capacities, these liquid based storage cells shall be housed in a separate, vented enclosure.

Enclosure

A typical indoor station shall be housed in a wall mounted 1,6 mm mild steel electrical type enclosure. Finish shall be epoxy coated grey. Swing-frame and 19" rack type enclosures are expensive and shall not be beneficial to the operation of the system on this project.

Weather resistant enclosure to IP55 specification shall be available as an option, and shall be included for wet environments e.g. pump rooms and valve chambers.

For an outstation location where no building protection is available (e.g.: a reservoir, borehole or pylon), a larger steel or fibreglass enclosure shall be used to protect the inner all-weather enclosure to IP55 protection. The outer enclosure shall provide vandal and weather protection, as well as ventilation around the inner enclosure. The assembly can be wall, base, or pole-mounted.

Communications Channel

- The Telemetry system must be able to operate on:
- Radio Channel (at 300 or 1200 baud FSK)
- GPO Landline/Pilot cable (at 300/1200/2400 baud FSK)
- Digital Radio, Microwave channel, Fibre optic and others (at up to 19200 baud).

Radio System

The telemetry system shall be suitable for use with digital radios, MDS 4710E/OEM or similar, single or dual frequency simplex UHF radios. The UHF radios shall be able to operate in the 420 to 470 MHz range. Synthesised frequency radios shall be preferred for this application.

The digital radio shall have a RS232 port available for interface to the telemetry equipment.

The radio shall be able to transmit at least 4800 bits per second over the air. The radio Output RF power shall be adjustable from 100 mW to 5 Watts.

No custom made radio or parts of radios shall be adapted for use on this project.

Radios offered shall be approved by the relevant Local Authority for this application.

Mast for Antenna

A 6 m tubular mast shall be fixed to the wall with a heavy gauge galvanised offset bracket for 500 mm roof overhang. The mast shall be 50 mm diameter, minimum 2 mm thick aluminium, for coastal applications, or galvanised mild steel for inland areas.

Antenna

The antenna selections shall be chosen to suit the project. No antennas are to be ordered prior to approval by the Engineer.

Surge Protection

Earthing

Basic earthing of mast, antenna and equipment is to be provided by the Contractor, and should be included in the Tender as follows:

- A 35 mm' bare copper conductor from the junction of the antenna and mast, to a 1,2 m earth pin buried vertically into the ground at the closest point below the mast.
- A 10 mm' bare copper conductor from the junction of the antenna and mast, to follow the co-ax cable, to the equipment enclosure.
- A 35 mm' bare copper conductor from the equipment enclosure(s) and surge protection modules to the earth pin. All earth cables to be as short as possible

Overvoltage Protection

The radio antenna input shall be protected using a Y wave shorted coax "stub" bonded to the earth point

Mains power input shall be protected by a surge protection device rated at 5 kA and shall be properly bonded to earth point.

Analog and Digital input signals and communications lines coming into the telemetry enclosure from the field (e.g. reservoir level transducers, float switches, flow meters pilot cable, GPO lines etc.) shall be protected by a suitable surge protection device rated at 5 kA and shall be properly bonded to earth point

Maintenance facilities

The telemetry system shall provide facilities to enable non-qualified personnel to be able to assess the proper operation of a station.

Indications

Display facilities should include the following:

- Indicating LEDs on each digital input and output line, control relay, etc.
- A display on the CPU module to view the system activity i.e. from whom it is receiving, to whom it is transmitting, what data has been decoded, error conditions and modes of operation.
- A method shall be provided to view the current analogue input and output values
- A pushbutton on the analogue module and the display on the CPU module may be used for this purpose.

Test Transmissions

A selector switch shall be provided to enable a Test Transmission to be sent and received from a selected outstation to assess the quality of communications. A handheld programmer should not be required for this facility.

Serial Port

A serial port (or RS232 module) shall allow a maintenance PC (e.g. lap-top) to be connected to monitor the entire communications system from any outstation. Suitable engineering level analysis software for this lap-top shall be included in this option to be offered.

Spares

The Tenderer shall allow for one complete spare module for each type used in this project (central and outstation) and the cost thereof shall be entered in the Bill of Quantities.

Transmission Scheme

Communications Algorithm

The telemetry CPU shall monitor the radio's RF carrier detect line as a channel busy indication. Should the channel be continuously busy (with no valid data detected, ego radio squelch opened) then the CPU shall switch automatically to the audio detect output of the modem and continue normal operation of data transfer.

An anti-collision algorithm based on the RF/Audio detect lines shall be implemented to avoid 2 outstations transmitting simultaneously. The algorithm can be based on the (unique) Station Address for each outstation.

Suitable lead-in time (pre-data PTI and audio tone) shall be allowed, to allow multiple repeater links to be keyed up, and the receiving modem can detect. Once keyed up (PTI) the outstation shall optimise radio time by concatenating commands into one transmission.

Error Detection

The telemetry system shall provide reliable and efficient information transfer. Error detection techniques and message protection shall be used to ensure maximum data integrity within the

radio telemetry system, Error detection shall be per command using 16 bit Cyclic Redundancy Code (CRG) as checksum, as well as context (structure),

The receiving station shall recalculate and verify the CRC, The received command shall be further checked for context, identification and destination, and shall be rejected if any of this information is not consistent. No error correction system shall be incorporated for received data,

Acknowledge Procedure

The Telemetry System shall be able to acknowledge messages received on the radio link, and be capable of re-transmitting a message if it is not acknowledged after a predetermined time-out period It shall be possible to select or de-select the acknowledge mode of operation. A station shall attempt 3 re-tries at transmitting a message, if it is not acknowledged,

Addressing

Every Telemetry System shall be allocated a System Number. This number shall be included in the data transmission for system identification purposes. The System Number shall be used as a means to allow two or more telemetry systems to operate in the same vicinity on the same radio frequency channel, or to implement Digipeating. Each Telemetry Station shall be allocated a unique Station Address. This shall be setup by means of thumbwheel switches on the CPU Module. Station addresses from 00 to 99 shall be available.

Each set of Inputs on an I/O Module shall be allocated a Data Encode Channel. Each set of outputs on an I/O module shall be given a Decode Channel. The Encode and Decode Channel numbers shall be included with the module's data in a command. Upon receipt of a data transmission, each station shall search for a match of the received Encode Channel to local I/O Module Decode Channel numbers, If a match is found; the data shall be transferred onto the corresponding set of outputs. Digital and Analog Control outputs shall thus be able to be sent between outstations. or from Central to Outstation

Modes of Operation

A telemetry station shall have three selectable modes of operation, namely INTERROGATION, CHANGE-OF-STATE, and TIMER, These modes of operation shall be selectable by Mode Select Switches on the CPU Module,

Interrogation Mode

A Master Station or SCADA Central shall interrogate all outstations. The station that is interrogated shall respond by transmitting all its I/O Module input data, so as to update central and all stations correspondingly. The SCADA software shall be able to interrogate stations under program control, based on user configuration (e.g. time or event based).

Change-of-State Mode

The Change-of-State Mode shall enable the station to transmit input information when any input data changes. e.g., a digital input changes state or an analogue input changes by more than a determined amount.

The Change-of-State Modes selectable shall include the following options:

Digital CAS enabled/disabled, digital inputs only,

Analog COS enabled/disabled (analogue cas is 10 % variance)

Digital inputs shall be 'de-bounced' in software, requiring that a state exists for longer than 300 ms before it is regarded as a change-of-state. The actual values of digital debounce, variance (10 %). for analogue inputs are default values. Commands should exist in the protocol to adjust these for each input module when using a SCADA Central Station.

Timer Mode

A station shall be able to be set to transmit its input information at regular time-intervals. At least four selectable periods shall be provided (3, 10, 30, 90 minutes).

Combinations

A Station shall be able to have any combination of the above modes selected as a combined operating mode. Any specific mode selected shall not be mutually exclusive of other modes, thus allowing a level of redundancy to be programmed into the system to improve system reliability in adverse communications conditions.

Time-Tagging

The telemetry system shall have the facility to time-tag all events at the outstation, and transmit this time-tag to the Central together with the event (e.g., Digital Change-of State or Analog Change-of-Value).

The clock at the outstation shall be hardware based (with crystal), not software derived. Events shall be time tagged to 1 ms resolution. Accuracy of time-tagged events should be 20 ms between events at an outstation, and 100ms between events at different outstations.

The Central Station shall pass this time-tagged event to the computer SCADA software. The SCADA must display these times (as opposed to the time of arrival of the event), The operator must be able to see which time-tags displayed are of remote origin, so that proper analysis of sequence of events between outstations can be evaluated.

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 EPROM (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,

Commissioning and Training

Factory Acceptance

A Factory Acceptance Test shall be conducted at the Contractor's premises prior to despatch of the equipment to site. The Employer and his Engineer shall be invited to attend, in accordance with the Contract.

Commissioning

After installation and run-up, a commissioning and handover procedure shall be followed for the Contractor to demonstrate proper operation of the system, in accordance with the Factory Acceptance.

Training

The Contractor shall be required to train technical personnel of the Employer in the proper operation and maintenance of the system.. Training shall be done on the premises of the Employer, Emfuleni Local Municipality, or as otherwise agreed. It is the Employees intention to obtain a very thorough understanding of the system. To this end, training shall be done in three ways:

Formal hands-on training sessions of the operating personnel in system operation, covering all software and hardware operational aspects. Tenderers shall Indicate the time allowed for this purpose, but the minimum period acceptable shall be a 2 day session.

During the installation phase, a person shall be designated by the Employer to be closely involved with the installation and commissioning process. The intention is not to interfere with the Contractors' installation team, but to do observation in order to obtain the maximum possible information regarding the installation, to enable efficient maintenance to be undertaken by the Employer/Emfuleni Local Municipality after final handover and expiry of the guarantee period.

Software instruction for computerised SCADA Central Stations shall be of 2 days instruction. During these sessions operators shall be familiarise regarding generation of reports by the system, setup of analogue limits, modification of displays, configuration of trend graphs as well as other operational requirements of the software.

Documentation

The Contractor shall provide 2 complete sets of manuals for all the systems and subsystems to be provided in terms of the contract. Hardware manuals shall be sufficiently detailed to enable the Employer's/Emfuleni's Local Municipality maintenance personnel to attend to maintenance functions. Drawings shall cover at least all aspects of physical subsystem assemblies, wiring diagrams and terminal connections. Software and operational manuals shall cover aspects of system start-up, setup and operation. Instructions shall be clearly understandable by a reasonably skilled operator. Custom software is not favoured and shall be avoided where possible.

VSD VARIABLE SPEED DRIVE

VSD 1 GENERAL

The new pump sets shall be driven by VSDs. The VSDs shall be supplied and installed inside dedicated cubicles within the MCC.

The Contractor shall ensure that all the available safeties within the motor are hardwired into the VSD control circuits.

The Contractor shall be responsible to ensure that the variable speed drive system, the motor and the PLC are fully compatible as a system.

The VSDs shall be suitable for centrifugal pumps with a squared torque characteristic. The Contractor shall guarantee the availability of spares for 10 years after Contract acceptance.

VSD 2 DETAILED REQUIREMENTS

The VSDs shall control the speed of the motors by carrying the frequency of the alternating current supplied to the motors. They shall operate on the Modified Sinusoidal Pulse-Width Modulation (PWM), suitable for driving the motors coupled to the pumps as specified elsewhere.

The system parameters shall be as follows:

- System voltage: 400V
- Motor voltage: 380V
- System fault level: 15kA
- Drive Type: 6 Pulse, Transistor Converter, DC bus, Thyristor / Diode Inverter
- Motor speed (Max): As determined by the motor supplier
- Motor speed (Min): As determined by the motor supplier

The output to the pumps shall incorporate chokes and / or dV/dT filters to suit the motors offered by the mechanical supplier.

Harmonic disturbances on the supply shall be limited by inclusion of input chokes and / or DC chokes to reduce the harmonic content to the following:

- Any individual harmonic voltage may not exceed 1%.
- The total harmonic voltage may not exceed 3%.
- The current harmonics may not exceed 5% of the current rating of the equipment.

An interface via Modbus, Fieldbus or Industrial Ethernet shall be provided for each VSD and this shall be connected to the PLC for full diagnostics and alarming.

All VSDs shall be rated to accept 15% overload of the motor shaft power required at any speed over the full speed range of the motor. Furthermore, all VSDs shall be capable of continuous rating at the specified load and power supply conditions (24 hours per day, 365 days per year).

The stability tolerance on speed control shall be better than 1% of the set point. Electrolytic capacitors used in the dc application of electronic equipment (e.g. filter circuits) shall be of the long-life grade complying with IEC Publication 384-4.

All semiconductor devices, power transformers, chokes and other components forming necessary parts of the drive equipment shall be suitable for the particular application with respect to their rated voltages, rated currents, temperature rise and service life.

Solid-state electronic components shall be used.

Digital control based on the latest microprocessor technology shall be used. However, standard products and components shall be used and purpose made systems shall not be acceptable.

The VSDs shall be equipped with MODBUS RTU Interface protocol with facilities to report all fault conditions on a first in first out basis as well as control functions and the parameters during normal running condition. A suitable data storage buffer shall be provided of sufficient capacity to ensure a real time record of the above information and of any other variables the Contractor consider necessary for fault diagnostics. Protection devices in the VSD shall be hardwired to ensure that an electrical fault within the controller trips the transformer feeder circuit breaker.

Electrical interlocks shall be provided to trip the VSD in the event the access doors to the power section and the DC sections of the drive are opened.

Preference shall be given to VSDs of the same make and supply as the PLC's offered. Installation.

VSD 3 INSTALLATION

The VSDs shall be installed inside dedicated cubicles of the MCC.

The VSDs shall be so arranged in their enclosure that ambient air circulated through the unit for cooling only pass over the VSDs heat sink. Air vents with suitable barriers and ventilation fans as per the manufacturer's design shall therefore be provided in the cubicles.

A remote display and control unit, mounted on the door of the respective cubicle of the MCC shall be provided with every VSD. This display shall allow control of the VSD as well as a means of monitoring the motor rotational speed.

The Tenderer's attention is also drawn to the ambient conditions of the site, in particular the height above sea level. Due to the potential heat build-up in the MCC, each VSD cubicle must be equipped with louvers and a form of mechanical division in the back of the cubicle separating the VSDs intake air from the discharge air to prevent short-circuiting of the cooling air flow.

VSD 4 PROTECTION

The VSD drives shall be provided with the following integral protection features.

- A separate motor protection relay shall be provided if these features are not integral of the VSD protection features.
- The Contractor shall explain how each requirement is met in his drive and shall supply detailed supporting literature for each item.
- Thermal Overload with current time characteristics matched to the thermal response curve of the drive motor.
- VSD and Motor Short Circuits and Earth Faults to protect the drive and the motor fully protected against internal and external short circuits and earth faults on the supply connections, transformers, the DC link, or on the motor. This protection shall preferably be instantaneous in operation and arranged to trip the supply. It shall not operate incorrectly if the drive is able to feed current to a supply side unless the condition is sustained for long enough to damage the drive components.
- Negative Phase Sequence Voltages to protect the motor and drive against negative sequence currents resulting from the presence of negative sequence voltages on the supply lines, or produced by unbalanced operation of inverters, etc. The protection shall detect the condition and stop the drive before it or the motor can be damaged. The drive shall be able to operate continuously at the rated output if the negative sequence voltage on the supply does not exceed 2.5%.
- Loss of Supply Voltage should the positive sequence voltage to the drive fall below 85% for longer than 1 second. The drive shall be disconnected without any damage to the rectifiers, thyristors, IGBTs or any other components in the drive liable to be adversely affected by a low supply voltage condition.

- An under voltage trip which is pre-settable to a minimum of 15% voltage drop shall be provided. If the voltage drops more than the pre-set voltage above, the drive shall trip automatically. In the event of the supply voltage returning to a value that is greater than the pre-set voltage in less than 2 seconds, which is also pre-sellable, the drive shall automatically start up. A facility to enable the flying start shall be provided on the drive.
- The variable speed drive system shall be able to tolerate a sudden total loss of power without any damage to the drive.
- High Supply Voltage in case the supply voltage rises above 110% for more than the safe withstand time for all components in the drive, it shall be disconnected automatically.
- Electronic equipment shall be provided with all protection equipment necessary to ensure that over-voltage, over-current, or other transient conditions shall not result in component failure. Such protection shall be arranged to disconnect the drive, where necessary for its safety.
- Phase failure protection in case of failure of one or more supply phases shall cause the drive to be disconnected sufficient rapidly to prevent damage.
- Incorrect phase rotation protection shall preventing start-up of the drive.

The drive shall also be protected against the following faults:

- Over voltage in the DC link
- Under voltage in the DC link
- Over current in the inverter Motor stalling
- Motor winding temperature
- Transient surges
- dv/dt and di/dt
- Over speed
- Audible and visible indication shall be provided for all trip and alarm functions

VSD 5 INDICATORS AND TRANSDUCERS

Any protection function or condition that originated and cause any drive shutdown shall be indicated clearly on approved operation indicators. All protection functions shall be complete with the necessary current and voltage transducers required for this purpose.

The following are examples of preferred indications to be displayed on the panel door. Contractors shall provide information of fault indications offered applicable to the equipment.

- Over speed trip,
- Instantaneous over current trip. Inverse time over current trip. Converter over temperature trip. Earth fault trip.
- Converter ventilation fan failure trip. Power supply low voltage trip.
- Back-up electronic trip.
- Supply phase-IOSS and incorrect phase rotation protection trip. Stator winding over temperature alarm/trip.
- Earth fault alarm/trip.
- External fault.

A potential free contact shall be wired to terminals in the VSD or PLC to indicate a system fault for remote indication.

VSD 6 CONTROLGEAR

The following minimum controls and instrumentation shall be provided on the front panel drive compartment:

- Start / Stop push buttons for local operations.
- Emergency stop push button.

- Test / Off / Normal: This switch shall operate with a key removable only in the normal position. In the test position the complete starting and tripping sequence shall be operational for testing without applying power to the motor.
- Protection trip reset push buttons.
- Indication test push button to test lamps. Speed control
- Trip signal lamp (Red)
- Run / Ready signal lamp (Green) VSD Healthy signal lamp (White)
- Stop / Emergency Stop push button (Red) Start push button (Green)
- Trip Reset push button (Blue)
- Lamp Test push button (White)
- Alarm Mute push button (Yellow)
- LCD Display of instrumentation functions.
- Ammeter on one phase with instantaneous reading and over scale facility. Speed indication.
- Non-resettable running hour meter.

MGS DIESEL GENERATOR

MGS 1 CONTRACTOR'S RESPONSIBILITY

The Contractor shall be responsible for the supply, installation, testing, commissioning and free maintenance during the Defects Notification Period of the installation detailed herein.

The Contractor shall provide all materials, equipment, labour and services necessary for the complete, safe and efficient operation of the electrical installation in accordance with the intent of this Specification and Drawings.

The works shall be carried out strictly in accordance with the following:

All regulations, standards and codes of practice as listed in Part 3D below

SANS 8528-1:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 1: Application, ratings and performance.

SANS 8528-2:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 2: Engines.

SANS 8528-3:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 3: Alternating current generators for generating sets.

SANS 8528-4:2008 Reciprocating internal combustion engine driven alternating Current Generating Sets: Part 4: Controlgear and switchgear.

SANS 8528-5:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 5: Generating sets.

SANS 8528-6:2008 Reciprocating internal combustion engine driven alternating Current Generating Sets: Part 6: Test methods.

SANS 8528-7:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 7: Technical declarations for specification and design.

SANS 8528-9:2008 Reciprocating internal combustion engine driven alternating current Generating Sets: Part 9: Measurement and evaluation of mechanical vibrations.

NRS 010-2	Stationary lead acid batteries
NRS 024-Part 1	Diesel alternator sets for fixed installations
NRS 026	Battery chargers, industrial type
SANS 013	The determination of performance (at net power) of internal combustion engine
SANS 529	Heat-resisting wiring cables
SANS 556-1	Low-voltage switchgear
SANS 10103	The measurement and rating of environmental noise with respect to annoyance and speech communications
SANS 10131	The storage and handling of liquid fuel
SANS/IEC 6034	Rotating electrical machines

In terms of Government Notice No 17548, it is the Contractor's responsibility to ensure that all electrical fittings installed comply with the relevant SANS safety standards, applicable to the particular class of fitting. In the event of fittings specified by the Engineer which do not comply with the SANS safety standards, it shall be the Contractor's responsibility to notify the Engineer immediately in writing, so that alternative fittings which do comply with the SANS safety standards may be timeously selected.

The Contractor shall not install any fitting under any circumstance which does not comply with the SANS safety standards unless specifically instructed in writing by the Engineer on an item for item basis.

Where a product is claimed to comply with the SANS safety standard by compliance to an alternative foreign safety standard recognised and accepted by the SANS, the Contractor shall obtain and submit proof of such acceptance. Where the SANS grants a permit for the use of equipment which does not carry the SANS/SABS mark, the Contractor shall submit copies of the permits and test reports to the Engineer at the time of tender.

All equipment tendered shall comply with the SANS safety standard as required by the above legislation. The Contractor shall provide copies of SANS certificates of compliance for electrical fittings upon request by the Engineer. No claim will be considered on the basis that equipment tendered did not comply with the relevant SANS standard.

MGS 2 SCOPE OF WORKS INCLUDED

The Generator Contractor's work shall be the complete diesel standby generator installation including commissioning of the following:

Standby Generator Plant: 375 KVA minimum output at 400V/50 Hz at 0.85 Power Factor. This is a prime power rating as defined in Clause 13.3.2 of SANS 8528-1.

Automatic Mains/Standby Changeover Switchgear Mains Failure Sensing plus seamless transfer from standby power back to mains

Circuit breaker protecting the out-going cable (This may be incorporated with the change-over switchgear.)

Control of Changeover Switchgear

Control Panel

Exhaust and Silencer Systems

Batteries and Battery Charger

Cooling System

Louvers

Water jacket heater(s)

Weatherproof sound attenuating enclosure

Signs, Notices and Labelling

Painting of Equipment

Workshop Drawings and Samples

Provision of own Hoisting and Lifting

12 months Free Maintenance and Services commencing at date of commissioning

12 months Guarantee commencing at date of commissioning

Removal of own Waste

The generator shall incorporate a 999 litre integral fuel tank mounted in the base of the set.

The Contractor shall also install a 4 500 litre bulk fuel tank with fuel lines, circulating pump and filter to limit algal build-up as discussed elsewhere in this specification.

MGS 3 WORKSHOP DRAWINGS, SAMPLES AND INSPECTIONS

The Contractor shall timeously provide workshop drawings and/or catalogues and/or of the following items for the Engineer's review:

- General and Connection Diagrams
- Control Panels
- Standby Generator Plant
- Exhaust System/s
- Proposed Physical Layouts of Plant and Equipment
- Details of Builder's Work Required
- Changeover Panels Where Supplied

Manufacture and delivery of these items shall not proceed without the Engineer's written instruction to proceed.

The Contractor shall timeously advise the Engineer that these items may be inspected at the manufacturer's premises to enable the Engineer to inspect the items at the manufacturer's premises prior to delivery.

MGS 4 TESTING AND COMMISSIONING

4.1 Pre-delivery Works Tests

A works test and/or inspection are required by the Engineer of the complete diesel-alternator set and changeover panel before delivery to site. The Engineer shall be given the opportunity to witness the above tests. The Contractor shall give the Engineer timeous notice when he is ready to undertake the test. The Contractor shall nevertheless undertake his own test as prescribed in the relevant Standards, Specifications and Contract.

During the execution of the test the Contractor shall record both steady state and transient load, voltage, frequency, oil pressure and engine temperature at regular intervals and shall provide the Engineer with an authenticated test report for his records.

The works test shall include full load tests and step load tests with an adjustable load bank provided by the Contractor.

4.2 Acceptance Inspection Test

Acceptance testing of the installation shall take place at a time prior to the contract practical completion date. The Contractor shall give the Engineer timeous notice of being ready for such tests.

The Contractor shall provide all necessary test equipment, materials and tools and competent staff for the performance of the acceptance tests of the complete installation on site.

The test shall be carried out on site with all details of the plant and its environs complete so that a full rated load test can be performed. A load bank is not required for site acceptance tests.

If any portion of the works fails to pass the tests, tests of the said portion after replacement or rectification of the fault at the Contractor's expense shall be repeated within a reasonable time upon the same terms and conditions. All reasonable expenses incurred by the Employer/Engineer by such repetition of the tests shall be paid to the Engineer by the Contractor and shall not be added to the contract sum. Final payments in respect of the generator contract works will not be certified before all payments due to the Employer/Engineer in this respect have been made. Should the works fail to pass the test and inspection, the time required to remedy faults shall form part of the contract period. The Contractor is advised to perform the test as timeously as possible to allow time to rectify faults within the contract period. The guarantee period on the contract will commence from the date of issue of the Agent's certificate of practical completion.

4.3 Type Tests

Type test certificates for the current design of the alternator shall be submitted with the tender. Machines for which type test certificates are not available are not acceptable. Routine test certificates shall be submitted to the Engineer prior to the final works test.

4.4 Maintenance Tests

Notwithstanding the successful testing of the equipment and test results the tenderer shall remain responsible for the satisfactory operation of the system as a whole for a period of not less than one year from practical completion.

4.5 Noise

The Generator Contractor shall arrange tests and measurements to prove compliance with SANS 10103 regarding generator plant noise inside the building and at the boundary of the premises.

The location of the generator may be regarded as an Industrial District in terms of Table 2 of SANS 10103.

MGS 5 SPARES

The Tenderer shall submit with his tender a detailed itemised list of spares recommended to cover the probable requirements for one year's maintenance of the plant. The list shall include individual catalogued parts numbers and descriptions.

MGS 6 OPERATING INSTRUCTIONS, PARTS LISTS AND MAINTENANCE MANUALS

The Contractor shall supply, after approval by the Engineer, one bound set of comprehensive operating instructions, parts lists, maintenance manuals and as-built drawings including the following details and information:

Contractor's and Supplier's details (name, address, email address, telephone and facsimile numbers)
Contractor's emergency (after hours) contact details
Cable Layouts, including Feeder and Control Cable Marking Numbers and Details
Control Panel/s

Changeover Panel/s
Spare Parts List
Tools List
Standby Generator Operating and Maintenance Manual
Test Certificates
Certificates of Compliance
Guarantees and Warranties

The contract will not be accepted as complete until these have been supplied, complete and to the satisfaction of the Engineer.

MGS 7 PARTICULAR REQUIREMENTS

8.1 Standby Generator Set

A 375 kVA 400 V 50 Hz prime power standby generator set in weatherproof sound attenuating enclosure shall be supplied and installed complete with the necessary control and changeover panels, wiring and interconnecting wiring.

All changeover switchgear shall be electrically and mechanically interlocked, fully automatic and contain all the necessary coils, main contacts, auxiliary contacts, relays and adjustable timers for correct operation. The timers, relays and auxiliary contacts shall be connected to prevent the simultaneous energising of both the main and standby generator supply switchgear.

8.2 Site Conditions

The site is located as described in Clause PSE 1.1 above.

Service Conditions:

Altitude:	1440 m above sea level
Maximum Daily Temperature:	35°C
Minimum Daily Temperature:	1°C
Relative Humidity;	20%
Atmosphere	Temperate
Pollution Level:	Medium
Mains Voltage:	400/230 Volt (nominal)
Mains Frequency:	50 Hz (nominal)

8.3 Operation

The diesel alternator set shall start up automatically after an adjustable period of 0-10 seconds (as determined by the Engineer) after detection of failure of mains power. The machine shall take load on attaining rated speed and voltage.

The machine and control shall be so designed and set so that the time from mains failure to load acceptance shall not exceed 15 seconds.

The transfer of load will be by means of motorised isolators. These are to be installed in a position remote to the generator. This position shall be in the MCC, which will be close to the generator.

The Contractor shall terminate the electrical power cables and pilot cable linking between the generator and the change-over isolators and between the changeover isolators and the MDB.

On sensing the return of the mains the machine shall continue to run on load for a period adjustable from 0 - 300 seconds after which time the transfer of power from emergency back to mains shall take place.

The control system shall be able to automatically do a seamless transfer back to Mains power.

On return of mains power the controller shall synchronise the output of the generator with the mains and then shall cause the mains motorised circuit breaker to close. Both the mains circuit breaker shall remain closed together for a time period of approximately 40 milliseconds and then the generator motorised circuit breaker shall open.

The machine shall run on at no load to cool the engine for a period determined by the manufacturer whereafter it shall automatically shut down ready for the next mains failure.

A plant selector switch shall be provided with off, manual, automatic and test positions which may be incorporated into a purpose designed controller.

In the automatic mode the machine shall operate as described above.

In the manual mode the machine shall be started by an accompanying start button after which it should take load as for automatic operation but shall be stopped by a stop button. The stop button shall cause the machine to shed its load and run on for its cool down period.

In the off mode the machine shall not operate.

In the test mode the machine shall start and run in response to operation of the start/stop buttons, but shall not take load. In the event of the mains failing during the test procedure the machine shall, however, take load automatically.

An emergency stop button shall be provided to shut the machine down instantly in any operating mode.

8.4 Engines

The engine shall be multi-cylinder vertical or inclined compression ignition two or four stroke naturally aspirated or exhaust gas turbo charged cold starting direct diesel injection water cooled type.

The engine shall be rated for standby power matched to drive the alternator and its imposed load at a speed of 1 500 rpm in accordance with SANS 8528 at site.

The engine shall be rated for 10% overload for a period of 1 hour without deviation from rated speed and without undue heating or mechanical stress.

8.4.1 Engine accessories

The engines shall be complete with the following accessories in addition to those elsewhere specified:

- Oil pressure gauge in kPa
- Water temperature gauge
- Non resettable running (hour meter) in the control panel
- Fuel shut off solenoid valve preferably continuously rated energised for engine to run
- Removable drip tray
- Dynamically and statically balanced fly wheel to limit cyclic irregularity to SANS 8528 requirements independently to the alternator inertia.

8.4.2 Engine protection

The engine shall be provided with the necessary transducers with accompanying relays to indicate separately the following conditions:

High oil temperature
Low oil pressure
Over and under speed exceeding 5% above or below rated speed
Start failure after 3 attempts

The engine shall shut down under the above conditions an alarm shall be provided in the control panel to indicate the event.

The above protection shall be interlocked with control circuits to prevent false indication during run up and run down periods.

8.4.3 Governor

An electronic governor capable of accurate speed regulation within SANS 8528 class G2 suitable for the imposed load shall be provided.

8.4.4 Starting

Battery starting shall be provided by means of an axial type starter. The starting circuits shall ensure that cranking stops as soon as the engine fires and that the starter does not re-engage until the engine is at rest.

The engine shall be provided with water jacket heaters to ensure easy starting and load acceptance as soon as rated speed and voltage are attained. Should the Contractor deem it necessary to ensure this condition he shall include for an electric oil circulating pump.

8.5 Step Loading

The plant shall be capable of accepting a step load from 0 – 65% of the nominal rated load with a voltage deviation not exceeding 15% of rated voltage and a frequency variation not exceeding 6% of rated speed. Voltage and frequency recovery shall be within 2 – 4 seconds and frequency in 2 seconds during motor starting while on load frequency and voltage variation shall not exceed the above limit and recovery time.

8.6 Cooling

The engines shall be water cooled by means of a set mounted radiator. The cooling system shall be commissioned with a rust inhibitor in the water.

8.7 Lubrication

The lubrication system shall be pressure fed with a reliable disposable element oil filter fitted between the pump and engine oil circuit. The filter shall have a bypass valve to maintain lubrication when the filter is choked.

8.8 Air Filters

The engine shall be fitted with a suitable air intake filter. Dry types shall be provided with a service indicator.

8.9 Exhaust Systems

The engine shall be supplied complete with an exhaust system and locally mounted exhaust silencer.

The Contractor shall install an exhaust extension to take the exhaust out of the generator room. The Contractor shall allow for an exhaust extension length of at least 4 meters.

The maximum noise level from the exhaust shall not exceed the SANS 10103 recommended residual sound levels for an industrial district as listed in Table 2.

Flexible couplings and mounting shall be provided between parts of the exhaust system fixed to the structure and the engine.

Where necessary both absorptive and resonator silencers shall be fitted to reduce noise below the above level.

The exhaust system shall be 3CR12.

The exhaust cladding shall be galvanised mild steel/stainless steel.

8.10 Fuel Systems

The set shall be fitted with a 999 litre integral fuel tank.

8.11 Alternators

The alternator shall comply with SANS 8528 Part 3. Protection shall be IP 22 or better and winding insulation shall be class H or better.

The alternator shall be the self excited, self regulated screen protected, drip-proof brushless type.

The voltage regulation expressed as a percentage rise in terminal voltage on the instant reduction of full rated load at 0,8 power factor to no-load shall not exceed 5%.

The alternator shall be of the two bearing type of the ball and/or roller type.

The electrical characteristics shall be as follows:

Voltage : 400V three phase 230V single phase.
Frequency : 50 Hz at rated speed of 1500 rpm.
Radio and TV interference suppression shall be fitted in accordance with SATRA/Telkom requirements.

The load imposed on the alternator will be as follows:

Lighting and small power	2 kVA
Motors controlled by variable frequency drives	2 x 132 kW i.e. 264 kW
Motor controlled by soft starter	12 kW

The minimum capacity for this plant shall be as follows:

Alternator:	375 kVA
Motor:	375 kW

Notwithstanding the specified nominal load capacity of the diesel standby generator, the complete set shall be capable of supplying both the transient and quiescent power, requirements imposed by the equipment above within the voltage and frequency limits specified.

This load excludes engine auxiliaries. The Contractor shall add the kVA loading of engine auxiliary equipment to the minimum power required when sizing the alternator.

8.12 Mounting

The engine and alternator shall be mounted on a common base and direct coupled with a flexible coupling. The engine and alternator shall be mounted on the base with anti-vibration mountings. Provision shall be made for bolting the base to the floor.

8.13 Battery and Battery Charger

The batteries shall be of the lead-acid stationary low maintenance type.

The batteries shall be of sufficient capacity to provide six starts in a one hour period.

The battery charger shall be mounted in the alternator control panel and shall automatically boost or trickle charge the batteries as determined by the battery voltage. The boost charge current shall not exceed 20% of the rated battery capacity. A constant trickle charge facility is not acceptable.

The method of charging the battery and charging equipment supplied shall have the prior approval of the battery manufacturer of the batteries the Generator Contractor intends installing.

8.14 Control Panel

The alternator set control panel shall be set mounted. The panel shall contain all the engine protection relays, timers, circuit breakers, battery charger, voltage regulator, mains sensing relays, motorised circuit breakers and wiring necessary for the complete safe and reliable operation of the diesel standby generator.

All terminals and equipment shall be labelled clearly with approved markers and legends. Each control wire shall be marked at each end. Markings shall correspond exactly with those on the switchboard circuit diagrams.

The Contractor on the project will supply install and connect/terminate where indicated by the Contractor the following cables:

- Power In;
- Power Output:

The control panel shall contain inter alia:

Alternator protection circuit breaker
Battery charger
Voltage regulator
Plant selector switch
Emergency stop button
Start/stop button
Demand indication ammeters
Voltmeters
Battery volt- and ammeter
Running hour meter
Reset buttons
Engine protection relays and indication
Frequency meter
Fuses
Terminals
Start delay, potential and stop delay timers
Run on timer
Three phase adjustable phase failure and rotation sensing relay

As much of the above as possible can be combined into a controller (except the emergency stop button).

Four coloured indicator lights shall be mounted in the panel, with clear labelling, to indicate the following:

Mains live
Mains on load
Standby live
Standby on load

Only circuit breaker toggles, push buttons and indication equipment shall be accessible. The balance of equipment shall be behind hinged doors. Perforated plastic trunking shall be provided wherever necessary to neatly house all control wiring.

8.15 Painting

Painting of equipment shall be in accordance with SANS 0140 part 2 specification LEE-P4A-1.

8.16 Noise and Attenuation

The maximum noise level from the set shall not exceed the SANS 10103 recommended residual sound levels for an industrial district as listed in Table 2.

The Contractor shall arrange testing and measurement to prove compliance.

The engine and alternator shall be mounted on the frame using anti-vibration mounts to prevent transmission of vibration to the structure. Where necessary the exhaust system shall be suspended on spring mounts to prevent transmission of vibration to the structure.

8.17 Remote Indication and Control Facilities

The Contractor shall provide a remote indication panel to show the following conditions:

Low fuel (30% capacity)
Common failure alarm
Generator running

The Contractor shall additionally provide potential free contacts for signalling these conditions to a Building Management System (BMS).

8.19 Emissions

Gas emissions from the generator set shall be compliant with the European Stage III standard.

8.19 Labels

All labels shall be English. All labels shall be of ivory or plastic and securely fixed by screws or rivets. Lettering shall be block capitals, minimum size 4 mm.

All feeder and control cables shall be identified with approved marked brass or fibre identifying discs at terminations, every 10 m (if practical) horizontally and at every floor level vertically. The Contractor shall provide diagrammatic charts showing the identity, type and size of each cable.

8.20 Danger Notices

The Contractor shall supply and install all danger and statutory notices in terms of the relevant regulations.

8.21 Corrosion

The Generator shall take adequate measures to protect the installations against corrosion, according to the site conditions.

MGS 9 TRAINING

The Contractor shall provide training to the Employer/Emfuleni Local Municipality at practical completion.

Training shall be provided in the routine operation and maintenance of the standby generator and related plant included in this subcontract.

MGS 10 GUARANTEE AND MAINTENANCE AND SERVICING

The Contractor shall provide a guarantee to replace or repair, free of charge, any part of the installation in which defects may develop as a result of manufacturing defects or poor workmanship during the Defects Notification Period.

Where products supplied normally carry a guarantee exceeding the Defects Notification Period, the full normal guarantee for the product shall apply.

After commissioning of the generator set the Contractor shall make four visits to site at three monthly intervals.

At each of these visits the Contractor shall carry out at least the following actions:

- Change oil
- Replace filters
- Check battery electrolyte levels
- Simulate mains failure and check for automatic starting of the set
- Complete a logbook recording the actions taken and the running hours of the set

During one of these visits an on-load test shall be conducted.

This will be discussed at project completion and arrangements will be made with the user department and supervisor.

The logbook shall be handed over to the supervisor at the end of the Defects Notification Period.

MGS 11 SCHEDULES OF INFORMATION TO BE COMPLETED BY THE TENDERER

MGS 11.1 TECHNICAL DECLARATIONS FOR SPECIFICATION AND DESIGN (Extract from SANS 8528 Part 7)

Tenderers shall fill in under Column M for all items unless N/A has been inserted by the Engineer.

No	Term	Item	Reference	C	M
4.1	Basic data	Power demand		375 kVA	
		Power factor		From 0.8 to 1	N/A
		Rated frequency		50 Hz	
		Rated voltage		400 V	
		Type of system earthing	SANS 10142	TNS	
		Profile of the connected electrical load	9.1 of SANS 8528-5	Continuous	N/A
		Required steady-state frequency and voltage behaviour	16 of SANS 8525-5	Class G2	
		Required transient frequency behaviour	16 of SANS 8525-5	Class G2	
		Type of fuel available	12 of SANS 8528-2	Refer South African Suppliers	
		Starting	15.1 of SANS 8528-5 and C.3.11 of SANS 8525-7	Electrical	
4.2	Engine	Cooling and room ventilation	15.6 of SANS 8525-5		
		Speed	6.2 of SANS 8525-2		
		Fuel specification	12 of SANS 8525-2	Diesel: Refer South African Suppliers	
		Nature and type of speed governor	6.3 of SANS 8525-2		
		Nature of engine cooling		Water cooled	
		Required operating time without refuelling	15.3 of SANS 8525-2	To be discussed	
		Required engine instrumentation	7.4 of SANS 8525-4	a,b,c,d,e,h	
		Required protection system	7.3 of SANS 8525-4	Over current, underspeed, control circuit protection	
		Fuel consumption	14.5 of SANS 8525-1		
		Starting system and ability	11 of SANS 8528-2	Refer Clause 8.4 above	
		Heat balance	9 of SANS 8525-2		
		Air consumption			

No	Term	Item	Reference	C	M
4.3	Generator	Nature and type of excitation and voltage regulation	14.7.2 of SANS 8528-1 a and 12 of SANS 8525-3nd 8	Class G2	
		Required mechanical protection	IEC 34-5	IP 22	
		Required electrical protection	7.3 of SANS 8525-4	Over current, underspeed, control circuit protection	
		Nature of generator cooling	IEC 34-5	Air	
		Heat balance	9 of SANS 8525-3		
		Unsymmetrical load (unbalanced load current)	8.2 of SANS 8525-3	As given in Clause 8.2	
		Construction and mounting arrangement	IEC 34-7	Refer Clause 8.12 above.	
		Grade of telephone and radio interference suppression	8.5 and 8.6 of SANS 8528-3	As given in Clauses 8.5 & 8.6.	
4.4	Mode of operation	Continuous	6.1 of SANS 8525-1	Yes	N/A
		Limited time operation (emergency generating set, peak load generating set)		As 6.1.5	N/A
		Expected operating hours per year		1 200	N/A
4.5	Power rating classification	Continuous power	13.3 of SANS 8525-1		
		Prime power		Yes	
		Limited-time running power			
4.6	Site criteria	Land use	6.2.1 of SANS 8525-1	Yes	N/A
		Marine use	6.2.2 and 11.5 of SANS 8525-1	No	N/A
4.7	Performance class		7 of SANS 8525-1	G2	
4.8	Single and parallel operation	Parallel operation with other generating sets	6.3 of SANS 8525-1	No	N/A
		Parallel operation with mains		Seamless transfer back to mains	
		Type and execution of synchronising			

No	Term	Item	Reference	C	M
4.9	Mode of start-up and control	Manual	6.4 of SANS 8525-1 and 6 of SANS 8525-4	No	N/A
		Automatic		Refer Clause 18.4 of Part 4 above.	N/A
		Semi-automatic		No	N/A
		Additional control device proposed by the generating set manufacturer			
4.10	Start-up time	Generator set with no specified start-up time	6.5 of SANS 8525-1	No	
		Long-break set		Yes.	
		Short-break set		No	
		No-break set		No	
4.11	Installation features	Installation configuration	8.2 of SANS 8525-1	Fixed	
		Set configuration	8.3 of SANS 8525-1	Enclosure	
		Type of mounting	8.4 of SANS 8525-1	Rigid	
		Weather effects	8.6 of SANS 8525-1	Inside	
4.12	Site conditions	Ambient temperature	11 of SANS 8528-1	35°C	
		Altitude		1440 m above sea level	
		Humidity		20%	
		Sand and dust		No	
		Marine		No	
		Shock and vibration		N/A	
		Chemical pollution		No	
		Type of radiation		No	
4.13	Emissions	Noise limitation	9 of SANS 8528-1		
		Exhaust gas limitations			
		Vibrations			
		National legislation		RSA	

No	Term	Item	Reference	C	M
4.14	Test methods	Standard	4 of SANS 8528-6	Yes	
		Special requirements		No	
4.15	Maintenance intervals	Routine (e.g. oil changes)		3 monthly	
		Mechanical (e.g. filters)			
		Electrical (e.g. controls)			
		Service life to major overhaul			
4.16	Auxiliaries	Power consumption of the auxiliary devices (e.g. fan, compressor)			
		Pre-heating			
		Pre-lubricating			
		Auxiliary and starting battery			
4.17	Control gear and switchgear	Rated current capacity	4.5 of SANS 8528-4	400 A	
		Neutral earth scheme	7.3.7 of SANS 8528-4	N/A	
		Fault-current rating	5.3 of SANS 8528-4	15 kA at changeover	
		Nature of protection device	7.3 of SANS 8528-4	Circuit breaker	
		Nominal operating voltage for control circuit.	4.6 of SANS 8528-4	48 V	
4.18	Factors affecting generating set's performance	With respect to power	9.2 of SANS 8528-5 and 14.2 of SANS 8528-1	Automatic starting of motors	
		With respect to frequency and voltage	9.2 of SANS 8528-5 and 14.2 of SANS 8528-1	Automatic starting of motors	
4.18	Other regulations and requirements		3 of SANS 8528-7	N/A	

MGS 11.2 GENERATING SET DATA

Tenderers shall complete the table below

No	Description	
1	DIESEL ENGINE	
1.1	General	
1.1.1	Manufacturer	
1.1.2	Model number	
1.1.3	Type	
1.1.4	Two stroke or four stroke	
1.1.5	Revolutions at 100% load	r/min
1.1.6	Number and arrangement of cylinders	
1.1.7	Total mass of set on base	kg
1.1.10	Starting period to full load	s
1.1.11	Engine run-down time	s
1.1.12	Fuel consumption under site conditions	
	a) Full load	ℓ/kWh
	b) ¾ load	ℓ/kWh
	c) ½ load	ℓ/kWh
1.1.13	Guaranteed power output under site conditions	kW
1.1.14	Gas emissions compliant with European Stage IIIA standard?	Yes/No
1.2	Mode of Operation (Standby/Continuous)	
1.3	Cooling	
1.3.1	Cooling medium	
1.3.2	Recommended coolant for closed circuit of engine	
1.3.3	Method of cooling, if one method preferred	
1.4	Aspiration and Cooling Air Intake(s)	
1.4.1	Type of air filter	
1.5	Starting System	
1.5.1	Method of starting	
2	INSTRUMENTATION	
2.1	Engine-driven tachometer	r/min Yes/No
2.2	Engine temperature gauge	°C Yes/No
2.3	Fuel oil pressure gauge	kPa Yes/No

2.4	Lubricating oil pressure gauge	kPa	Yes/No
2.5	Oil temperature gauge	°C	Yes/No
2.6	Starter battery voltage	V	Yes/No
2.7	Running hour meter	h	Yes/No
No	Description		
2.8	Dirty filter indicator (if applicable)	Yes/No	
2.9	Other instrumentation recommended		
3	ENGINE CONTROLS		
3.1	Manual start key/switch		
3.2	Shutdown in case of fire		
4	ENGINE LABELLING		
4.1	Grade of oil		
4.2	Danger label		
4.3	Information labels		
4.4	Rating plates		
5	ALTERNATOR		
5.1	General		
5.1.1	Manufacturer		
5.1.2	Model number		
5.1.3	Rated output	kVA	
5.1.4	Maximum short-circuit current	kA	
5.1.5	Guaranteed net continuous site rating	kVA	
5.1.6	Power factor at net continuous site rating		
5.1.7	Time intervals for applying loads		
5.1.8	Number of phases		
5.1.9	Phase-to-phase/phase-to-neutral voltage/..... V	
5.1.10	Range of adjustment of terminal voltage	±.....%	
5.1.11	Frequency	Hz	
5.1.12	Nominal speed	r/min	
5.1.13	Efficiency at unity/0.8 lag power factor		
	a) Full load	%	
	b) ¾ load	%	
	c) ½ load	%	
	d) ¼ load	%	
5.1.14	Excitation method		

	a) Excitation voltage range	V
	b) Maximum field control current	A
5.1.15	Parallel operation (if required)	Yes/No
5.1.16	Neutral earthing method	
5.2	Alternator Protection	
5.2.1	Overcurrent and earth fault protection (Required)	

Item	Description	
5.2.2	Other protection	
5.3	Alternator labelling (adjacent to alternator)	
	a) Danger label	
	b) Terminal label and colours	
	c) Information labels	
	d) Rating plates	
5.4	Transient output variations	
5.4.1	Maximum voltage drop during a load step of 225 kVA	%
	Maximum frequency deviation during a load step of 225 kVA	%
5.6	Alternator construction	
5.6.1	Number of bearings	
5.6.2	Are there special bearing and lubrication requirements?	
	a) If Yes, details of requirements	
	b) If No, details of bearings offered	
5.6.3	Alternator cooling	
6	MECHANICAL BUILD	
6.1	Base frames	
	a) Length	mm
	b) Width	mm
6.2	Equipment mounted on the base frame or separately	
6.2.1	Control cubicle	
6.2.2	Day fuel tank	
6.2.3	Battery for starter motor	
6.2.4	Battery for control circuits	
6.2.5	Other accessories	
6.3	Overall mass of set (for lifting purposes)	
6.3.1	Cable entry positions	
6.4	Coupling method	
6.5	Vibration damping mounting details	

Item	Description	
6.6	Enclosure	
6.6.1	Sound-reducing	
6.6.2	Weather protection	
6.6.3	Material used for soundproofing	
6.6.4	Corrosion-protected material used for the enclosure	
6.6.5	Internal illumination details	
6.6.6	Overall dimensions and mass	mm
	a) Length	mm
	b) Width	mm
	c) Height	mm
	d) Mass	kg
	e) Layout of proposed construction supplied	

Item	Description	
7	EXHAUST SYSTEM	
7.1	General	
7.1.1	Maximum flow resistance of exhaust system	kPa
7.1.2	Exhaust line diameter	mm
7.1.3	Maximum outlet noise level	dBA
	At	m
7.1.4	Silencer details	
	a) Manufacturer	
	b) Type/model number	
	c) Diameter	mm
	d) Length	mm
	e) Mass	kg
8	Materials	
	Exhaust line material	
	Details of expansion bellows	
	Lagging	
	Type of lagging offered	
	Thermal capabilities of lagging offered	
9	SWITCHGEAR	
9.1	Switchgear equipment	
	Equipment to be supplied	
9.1.1	Voltmeter	
9.1.2	Frequency meter	
9.1.3	Maximum demand ammeters	
9.1.4	kW meter	
9.1.5	Battery voltmeter	
9.1.6	Battery ammeter	
9.1.7	Mains isolator	
9.1.8	Alternator circuit breaker, details	
9.1.9	Changeover circuit breaker or contactor	
9.1.10	Cable termination terminals	
9.1.11	Neutral and earth bar	
9.1.12	Other equipment deemed necessary or recommended	
10	CONTROL PANEL AND SYSTEM	

8.1	Mechanical construction	
8.1.1	Panel height	mm

Item	Description	
8.2	Protection alarms and indications	
8.2.1	Alarm system, general requirements	
	a) Type of display offered	
	b) Remote control and indication alarm system	
8.2.2	Engine alarms	
	a) Low oil pressure	
	b) High engine temperature	
	c) High bearing temperature	
	d) Low coolant/water level	
	e) Engine overspeed	
	f) Engine start failure	
	h) Engine running	
	i) Day fuel tank low	
	j) Engine management system	
	k) Other alarm (including low battery voltage)	
8.2.3	Alternator alarms	
	a) Overload	
	b) High winding temperature	
	c) High output voltage	
	d) Low output voltage	
	e) Phase unbalance	
	f) High/low frequency	
	g) Earth fault	
	h) High bearing temperature	
	i) Unbalanced load	
	j) Reverse power	
8.2.4	General	
	a) Battery charger failure	
	b) DC fail	
	c) Mains fail	
	d) Fire valve(s) operated	
	e) Protection trip	
	f) Protection off/normal	
	g) Alarm system failure	

8.2.5	Engine alarms, indications and controls: recommendations	
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Item	Description	
8.2.6	Alternator alarms, indications and controls: recommendations	
11	CONTROL AND TIMERS FOR STANDBY SETS	
11.1	Mains fail	
11.2	Changeover delay timer range to s
11.3	Off-load run timer range	s
11.4	On-load run timer range	s
12	CONTROL EQUIPMENT	
12.1	Type of control system offered	
12.2	If system is PLC based	
12.2.1	Software documentation provided	
12.2.2	Writer of software	
12.2.3	Flow chart to be submitted	
12.2.4	Hard wired manual override facility	Yes/No
13	BATTERIES AND BATTERY CHARGER	
13.1	Batteries	
13.1.1	Starter battery	
	a) Type	
	b) Manufacturer	
	c) Voltage	
	d) Capacity	V
	e) Location	Ah
13.1.2	Control and alarm batteries	
	a) Type	
	b) Manufacturer	
	c) Voltage	
	d) Capacity	V
	e) Location	Ah
13.1.3	Other battery (if required)	
	a) Type	
	b) Manufacturer	V
	c) Voltage	Ah
	d) Capacity	
	e) Location	

	f) Purpose	
13.1.4	Battery charger	

Item	Description	
14	EARTHING	
14.1	Alternator neutral earthing	Yes/No
14.2	Battery earthing	
14.2.1	Is negative pole earthed to frame?	
14.3	Is bypass earthing of bearings recommended and provided?	
15	CORROSION PROTECTION AND FINISH	
15.1	Final colour of finishes	
15.1.1	Engine	
15.1.2	Alternator	
15.1.3	Frame	
15.1.4	Enclosure (if applicable)	
15.1.5	LV switchgear	
17.1.6	Control panels	
15.1.7	Other	
16	SPARES AND SPECIAL TOOLS	
16.1	Confirmation that all spares will be available for ten years from equipment delivery	
17	MARKING/LABELLING/DOCUMENTATION	
17.1	Labelling	
17.1.1	Are labels language or pictorial type?	
17.2	Documentation	
17.2.1	Number of copies of O&M Manual	
17.2.2	Number of copies of works test certificates	

MGS 11.3 SCHEDULE OF RECOMMENDED PARTS AND SPARES

ITEM	DESCRIPTION	CATALOGUE PART NO
1	ENGINE PARTS:	
2	ALTERNATOR PARTS:	
3	AUXILIARIES:	
4	OTHER:	

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MT INSTRUMENTATION AND METERING**MT 1 INSTRUMENTS AND METERING: GENERAL**

All instruments, gauges and control gear that perform similar duties shall be of uniform type and manufacture throughout the Works in order to facilitate maintenance and the stocking of spare parts.

Panel mounted instruments shall have damp-protecting and dust-protecting cases. Instruments mounted outside instrument panels shall have weatherproofed and dustproof cases. Instrument cases shall be of corrosion-resistant material or finish. Instrument screws (unless forming part of a magnetic circuit) shall be of brass or bronze. Access to terminal compartments of instruments mounted outside panels or other enclosures shall not expose any working part. Moving parts and contacts shall be adequately protected from the ingress of dust.

Unless otherwise specified instruments shall be finished in the manufacturer's standard colour. Instrument dials shall be of such material that no peeling or discoloration shall take place with age.

Plant-mounted indicators and gauges shall be sized to give full legibility when viewed from a position with convenient and easy access or from the point at which any operation requiring observation of the gauge is performed. The minimum diameter for any gauge shall be 100mm except where forming part of standard instruments and accessories.

Dials and bezels shall be of bronze and internal components shall be of stainless steel, bronze or other corrosion-resistant material.

Plant mounted in enclosures shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other Plant. All components shall be rated adequately and circuits shall be designed so that changes of component characteristics within the manufacturers' tolerances shall not affect the performance of Plant. All Plant shall be designed to operate without artificial cooling. Instruments shall be easily withdrawable from cases without interrupting their circuits.

Plant provided with anti-condensation heaters shall be capable of operating without damage if the heaters are left on continuously.

Measuring instruments shall have zero and span adjustment.

Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steelwork and weatherproof enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and maintenance. Instruments mounted in open areas that could be vandalised shall be mounted in lockable vandal proof boxes.

MT 2 ELECTROMAGNETIC FLOW METERING

Electromagnetic flowmeters shall comply with the requirements of BS EN ISO 6817:1997. They shall operate on electromagnetic induction principles and give an output signal directly proportional to the liquid rate of flow.

Each meter shall have a stainless steel metering tube (detector head) and a nonconductive liner suitable for potable water. End connections shall be steel flanged. The detector head shall be complete with corrosion resistant earthing rings and matching flange adapters of the self-locking type suitable for use on the pipes. One flange of the detector head shall be connected to a flanged pipe, while the other shall be connected with the flange adapter to facilitate removal.

The flow meter shall be carefully sited in the process pipework in accordance with as 5792 and the flow meter supplier's instructions. Particular attention should be paid to the provision of the correct velocity range, earthing rings and the correct number of upstream and downstream clear diameters. A bypass and isolating valves shall be provided to allow the removal of the flow meter for maintenance.

The Contractor shall provide any taper pieces necessary to give the correct velocity range through the flowmeter.

The primary flow head shall be suitable for continuous submersion to BS EN 60529:1992 IP6a or better. The maximum depth of submergence shall be three metres. The primary flowhead shall have electrodes that may be removed for cleaning or replacement without interrupting the flow.

Plant mounting enclosures for signal converters shall be to IEC 529, standard IP65 or better. Measuring ranges shall be continuously adjustable from 1 to 9.999 metres per second with facility to change to 0.5 to 5.5 mls for high accuracy measurement of low flows.

For flows between 50-100% of the range, the accuracy shall be better than or equal to 0.5% of the actual flow rate;

for flows between 10-50% of the range accuracy shall be better than or equal to 0.3% of the actual flow rate;

and for flows between 1-10%, accuracy shall be better than or equal to 0.1% full scale value.

The effects of ambient temperature on the output signals shall not exceed 0.15% per 100degC.

MT 3 LEVEL SWITCHES AND INDICATORS

Level transmitters shall be of the float, pressure bulb, displacer, diaphragm or air bubbler types. Float-operated transmitters shall have counterweights. Floats and displacers of transmitters and switches shall be of corrosion-resistant material or shall be coated with epoxy resin.

Level switches of the buoyancy type shall consist of a mercury switch with changeover action enclosed in a non-corrosive material. A balance weight shall also be incorporated in the switch to counteract the buoyancy effect for the specific gravity of the particular fluid. The connecting cable shall be sealed into the switch.

Buoyancy switches shall be installed with a minimum of two metres of spare connecting cable neatly coiled at a supporting bracket. The connecting cable fixing shall facilitate any alteration in operating level within the limit of the spare cable.

Level switches operating on the conductivity principle shall have three electrodes per relay or control unit except where a differential between the 'cut-in' and 'cut-out' values is not required or where two or more relays are associated with the same vessel, when a common "earth" electrode shall be used.

Electrodes for the same vessel shall be mounted on a common plate that shall be made in sections if desirable to facilitate handling. Electrode heads shall permit an adjustment in operating levels of not less than 90mm without necessitating cutting or extending electrodes.

Electrodes shall be of a noble metal to resist corrosion, and shall be insulated for most of their lengths. The thickness of electrodes and points of intermediate support shall be chosen so that no bending of the electrodes occurs under Plant operation conditions. This includes temporary bending.

Relay units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall have conductivity discs.

MT 4 PRESSURE GAUGES

The equipment shall be supplied and installed complete with mountings, housings, tubing, fittings, etc. necessary for the display of pressure in pipes.

The Contractor shall be responsible for the provision of detail information for the successful and complete installation of his equipment, and for carrying out the installation, testing and commissioning.

Pressure gauges shall comply with BS EN 837-1: 1998. Pressure gauges, transmitters and switches shall have over range protection.

No plastic material shall be used. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material. Pressure gauges shall have concentric scales.

Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation shall be marked on the dial.

The gauge shall have a range of measurement not less than 1.25 times the operational range of the equipment to which it is connected. In cases where gauges are used to indicate pressures above and below atmospheric pressure, the gauge range shall be not less than 125% of the maximum positive and maximum negative pressure.

The normal working pressure shall be indicated at a point between 50% and 75% of the full-scale deflection of the gauge.

The instrument shall indicate accurately to within 3% of the full-scale deflection.

All pressure gauges shall be equipped with an isolating valve or a gauge cock to allow it to be isolated from the pipe. The cost of the valve or gauge cock shall be deemed included in the tendered rate for the equipment.

Where a pressure gauge is to be installed on a pipe conveying corrosive liquids or slurries, or where there is a risk that the pressure ports of the gauge could become blocked as a result of the properties of the medium conveyed, such gauges shall be equipped with gauge protectors.

Glycerine-filled gauges shall be used for applications involving hydraulic pipelines, while vacuum-damped gauges shall be employed where they are to be installed on air or gas lines.

Labels shall be provided, especially on remote-mounted gauges, to indicate the locations where pressure is measured.

The operating set point of all meters and indicators shall be clearly marked in red.

After installation, pressure gauges shall be tested and commissioned together with the equipment to which they are connected, such as pumps or compressors and their associated pipework.

MT 5 ELECTRICAL INDICATORS AND INTEGRATORS

Indicators for use with analogue signal transmission systems shall comply with BS 89 and have an accuracy class index of 1.0. Indicator movements shall be critically damped (dead-beat). Indicators for use on more than one circuit shall have rotary switches to select the circuit, with engraved plates to show the circuit selected.

Indicators shall have circular scales or shall be of the vertical edgewise type and shall be designed to avoid parallax error. Scales shall be clearly marked in the specified units and shall comply with BS 3693. All instruments that are mounted on one panel or board, or are in adjacent groupings, shall have similar styles of figures and letters. Dials shall be white with black scales and lettering not subject to fading.

The material for scales shall be such that no peeling or discoloration shall take place with age under all environmental conditions.

Major scale marks and numerals shall be of the same size and thickness and shall be separated by not more than twenty five minor marks. Pointers shall taper to the width of the scale marks.

Integrators shall be of the multi-digit cyclometer type. Each integrator shall have an integral or separate current-to-pulse converter with sufficient adjustment of the pulse rate to avoid the use of any multiplying factor except in integer power of ten. Each integrator shall incorporate an adjustable limiter whereby any input below a pre-set value is inoperative. Unless otherwise specified, integrators shall have a minimum of eight digits with a decimal point where applicable.

MT 6 LEVEL INSTRUMENTATION

Ultrasonic Devices

Ultrasonic level measuring devices shall offer the minimum facilities described below:

Level sensor

The sensor head shall be protected to IP68.

Sensing heads shall be mounted on stainless steel brackets and positioned with due regard given to an unhindered beam path and within easy reach of maintenance personnel.

Signal converter

The signal converter shall be supplied in an IP55 (indoors) or IP65 (outdoors) minimum polycarbonate enclosure and shall comprise a base unit and a programming device.

Communication between the programmer and signal converter shall be in such a manner that the IP rating is not prejudiced.

A 3.5" or larger digit liquid crystal display shall be used to indicate key programming features, settings and output conditions. The display shall be in the English language. The unit shall also be provided with a keypad for calibration and configuration.

The unit shall be suitable for either 24 V dc or 240 V ac operation.

Accuracy of the signal converter shall be better than $\pm 0.5\%$ of reading.

The signal converter shall have the following programmable outputs:

- 4-20 mA proportional to user definable engineering units;
- SPOT relay contact output closing upon failure of the signal converter or lost echo
- 3 off SPDT contact outputs with independently set trip points.

These outputs shall be programmed to energise upon high/low level, rate of change or to allow a number of pump sequencing operations.

Conductivity Electrodes And Level Relay Systems

Conductivity electrodes shall be formed from stainless steel tubes encapsulated in PVC sleeving down to 75mm from the end of the electrode. The electrode shall be sealed.

Where necessary, intermediate insulated support brackets shall be installed to prevent the electrodes swaying. The intermediate supports shall be installed above normal top water level at the particular location. An earth electrode shall be provided at each electrode installation. Pipework shall not be used for the earth.

The electrode holders shall comprise a moulded back phenolic body capable of accepting 20mm BS pipe. Plated clamping collars complete with cable termination shall be provided to locate the electrode. The holder cap shall also be of moulded phenolic material. A gasket shall be placed between body and cap. The body shall be arranged to receive screwed conduit

Electrode holders shall permit adjustment in operating levels of not less than 100mm without necessitating cutting or extending electrodes.

Relay units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall have conductivity discs. Electrodes shall be energised with an alternating voltage not exceeding 25 V open circuit

Pressure Devices

Pressure transducer level measuring sensors shall be of the stainless steel submersible type operating on the piezo-resistive silicon strain gauge principle. Compatible power supply and signal processing units shall be provided with protection against radio frequency interference and supply transients. The final output shall be a 4-20 mA signal proportional to level. Lightning protection shall be provided where applicable.

The transducer/cable shall be suitably supported with stainless steel brackets. A bracketed stainless steel restraining tube shall be provided in deep sumps etc.

EAH MOULDED CASE CIRCUIT BREAKERS

EAH 1 GENERAL

Moulded case circuit breakers and isolators shall be of the triple, double or single pole, hand operated, panel mounting air break type, and shall comply with SANS 156. They shall have continuous current ratings as specified and shall be suitable for operating at the rated voltage. Earth leakage relays shall comply with SANS 767.

EAH 2 MOULDED CASE CIRCUIT BREAKERS

The circuit breakers shall have:

- Temperature compensated thermal-magnetic or hydraulic magnetic type operation.
- Individual trip elements enclosed and sealed in units of approved moulded composition.
- A quick-make and break mechanism, insuring full contact pressure to time of opening and tripping free.
- Non-welding type contacts.
- Automatic tripping clearly indicated by handle automatically assuming position distinctive from normal "on" and "off" positions.
- Inverse time-overload characteristics to prevent tripping on momentary overloads, but shall trip before dangerous current values are reached,

Interrupting capacities referred to are asymmetrical values.

EAH 3 MOULDED CASE ISOLATORS

The contacts are to be silver alloy and the switch mechanism shall be of the quick-make, quick-break type.

The switches are required to open and close circuits carrying currents up to the full current rating of the switch, and shall be fitted with arc chutes.

To distinguish the switches from circuit breakers the operating handle shall have a distinctive colour, preferably red or green, or other clear indelible indication.

EAH 4 EARTH LEAKAGE RELAYS

The condition of service of the earth leakage relays, as regards methods of connection, number of outlets, whether for single phase or three phase use, and the rating of the associated circuit breaker tripping coil shall be as specified.

The relays shall operate on the core balance principle to energise the trip coil of the associated circuit breaker by means of a static switching device or magnetic amplifier of simple design.

The sensitivity and response of the relay shall be such that instantaneous tripping shall occur at total earth leakage of 20 milli-amperes where portable tools shall be used.

For fixed machinery, circuits shall be generally protected by earth leakage units with the following nominal sensitivities, except where noted.

Maximum Continuous Current Nominal Sensitivity = 30mA

The relays shall be fitted with integral test facilities and shall have compensation for ambient temperature variations and protection against high earth fault currents. Stability against line disturbances and the maintenance of sensitivity are essential.

EAN METERING EQUIPMENT

EAN 1 GENERAL

Metering equipment shall be provided in accordance with SANS 01 and BS 37. Work shall be carried out to meet municipal requirements and as noted.

The supply authority shall meter the electricity consumption at a central supply point.

Metering equipment on the Main LV Switchboard shall be supplied by the Electrical Contractor.

EAN 2 KILOWATT-HOUR METERS

The kilowatt-hour meters shall be of the house service type, approximately 162 x 112 x 100 mm deep, of robust construction, housed in a dust proof sealed metal or plastic case shall utilise a magnetic suspension for the disc and shall comply with BS 37.

The meter element shall be suitable for operation on single phase, or three phase as specified, 50 Hertz AC system and shall be of the inductor type, capable of continuously carrying the rated current. Accuracy shall be "Commercial Grade" as defined in SAN S 01.

The registering mechanism shall be of the cyclometer type giving a reading of six figures, the lowest indicating tenths of a unit.

The meters shall be suitable for the supply voltage specified and the rated current shall be as directed.

EAN 3 VOLTMETERS

Voltmeters shall be of the moving iron flush mounting type, rectangular or circular and size as specified. They shall be suitable for vertical switchboard mounting and studs shall be provided for back connection. The voltmeters shall be suitable for operation on a 50 Hertz system, and be calibrated as required. The voltmeters shall be manufactured in accordance with BS 89 to industrial grade accuracy as specified therein.

The voltmeters shall be protected by high rupturing capacity fuses to SANS 172 housed in suitable insulated fuse carriers with a panel-mounting base. Voltmeter selector switches shall be incorporated.

EAN 4 AMMETERS

Ammeters shall be of the moving iron flush mounting type, in accordance with Clause 3.1 above where applicable, and of the pattern, size and scale range as specified.

Ammeters for use in motor circuits shall have a suitably compressed overload range.

Ammeters selector switches shall be installed if specified. Selector switches having spring-loaded contacts running over copper segments are not acceptable.

EAN 5 COMBINED MAXIMUM DEMAND AND INDICATING AMMETERS

The instruments shall be flush panel mounting, rectangular in shape, the dial size being approximately 125 x 125 mm or 80 x 80 mm as specified. The ammeters shall comply with BS 89.

The instrument shall comprise a moving iron ammeter showing the instantaneous current value, combined with a maximum ammeter employing a bimetallic spiral device which shall indicate the mean current value on the basis of a 15 or 30 minute period as noted, and which is fitted with a residual pointer to indicate the maximum mean current reached during any period between manual resetting.

All three indications shall be registered on concentric scales, and instruments having small moving iron ammeters with window cut-outs scales are not acceptable. The bimetallic system shall incorporate ambient temperature compensation.

The instrument shall be used with a current transformer having a 5 ampere secondary winding. 6 Ampere or 8 ampere instruments may be offered, scaled to the full load primary current of the current transformers, with an additional overload scale in the case of 6 amp instruments.

EAN 6 POWER FACTOR INDICATORS

PF Instruments shall be housed in pressed steel cases. Shadowless scale plates shall be fitted. Instruments shall comply with BS 89. Indicators shall be suitable for flush mounting in switchboards. Current rating shall be 0.5 to 5 A continuous at the rate voltage. Power factor range shall be from 0.5 PF lead to 0.5 PF lag, and size shall be as specified.

EAN 7 ELAPSED TIME METERS

Time meters shall be of the flush mounting type, square phenolic frame, suitable for switchboard mounting. Registers shall be calibrated in hours and tenths of hours. Cyclometer details to be as noted. Voltage range shall be 200 - 250 V 50 Hz unless otherwise noted. Motors shall be self-starting, synchronous, non-reversing and shall be energised from the same supply as the apparatus being metered.

EAN 8 TRANSDUCERS

Transducers shall be suitable for use in remote indication systems for alternating current and voltage using lightweight telephone type pilot wires. Outputs shall be suitable for operating moving coil instruments and recorders.

Outputs and Inputs shall be as specified.

Output currents shall be independent of the load resistance over the stipulated range of load resistance.

Ambient temperature range – 1°C to :l: 500°C.

Accuracies and linearity shall be according to the application as specified.

Open circuit: DC output voltages shall not rise above 18 volts when the load is removed or open circuited. Open circuiting of the output shall not result in damage to the transducer.

Short circuit: DC outputs shall be protected against a short circuit of the output terminals by a current limiting device.

Voltage, kWatt, kVA transducers shall be suitable for 3 wire unbalanced loads or as otherwise specified. Amplifiers shall be utilised where transducer outputs do not meet the required output range for the system.

EAN 9 LABELS

Labels shall be provided, as specified, to indicate the circuits in which measurements are made.