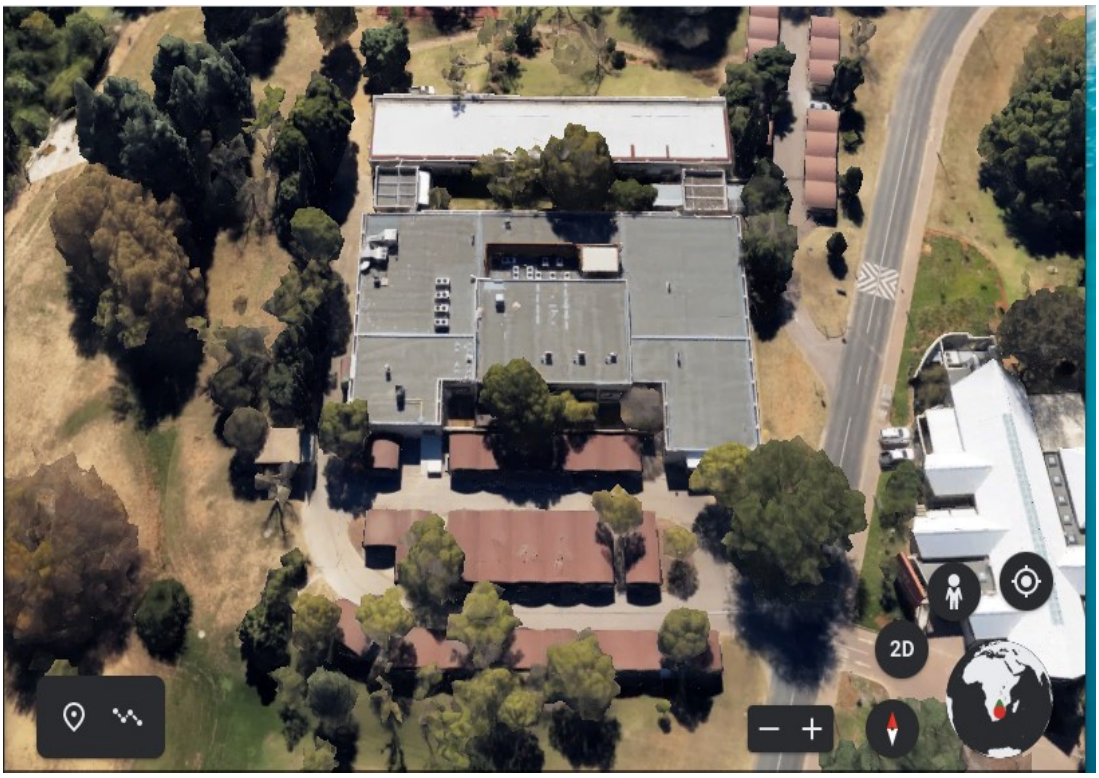
CONSULTING ENGINEERS (PTY) LTD	**DETAIL DESIGN DOCUMENT**	**Template Identifier:**	**Project No. P181**
		Purchase Order:	**1000782389**
	The design and implementation of back-up Generators and upgrade of the existing MLV distribution board at CSIR	**Authorisation Date:**	**2022.02.19**
LO937		**Revision Date:**	



STAGE 1 - CONCEPT DESIGN REPORT
BUILDING 9 DC GENERATOR INSTALLATIONS
REVISION 00 - FEBRUARY 2022

PREPARED FOR:

Contact Person: Mr Abongile Gobeni
CSIR Pretoria - Building 9
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CSIR
Touching lives through innovation

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CONSULTING ENGINEERS (PTY) LTD
25th
CESA

PROJECT NAME: ***Back-up Generator and upgrade of the existing MLV distribution board***

PURCHASE ORDER NUMBER: 1000782389

1. Executive Summary

PLP Consulting Engineers (Pty) Ltd has been appointed by CSIR, Pretoria, as Professional Electrical Consulting Engineers to prepare the Concept Design report for this project.

The existing 1 MVA generator will be removed from the data center IT load, and two new generators will be installed as data center back up electrical supplies in an N+1 redundancy scenario.

The existing MLV board will be replaced with a new Board, CSIR envision an almost maintenance free MLV board where the board will have online thermal scanning and some of the MCCB's will have micro logics to enable CSIR to monitor power quality and consumption alike further the new MLV board will feed the whole of building 9 and the data center.
All infrastructure will have early warning using the most appropriate technology where notification will be sent to CSIR maintenance personnel using SMS, messaging service, and or e-mails.

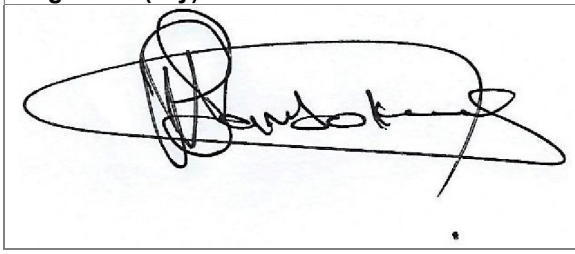
PLP Consulting Engineers (Pty)Ltd objective is to assist the CSIR Team with the Assessment and Redesigning of the existing MLV Boards and the Generator installations, construction monitoring and handover of the new propose installation. The task will be executed according to the Standard Scope of Professional Services associated with the delivery of a package for CSIR.

2. Stake holders:

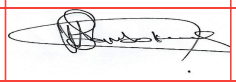
- **Employer:** CSIR.
- **Projects Manager:** Mokete Sekiba, Cell: (064) 536 1749, Msekiba@csir.co.za)

3. Authorisation

Compiled By:		**Approved By:**	
Name:	**P.V Sambokwe (Pr. Tech)**	**Name:**	**F.P. Pieterse (Pr. Eng.)**
Tel:	**(012) 807 6437**	**Tel:**	**(013) 741 4499**
Date:	**2019.12.06**	**Date:**	**2019.12.06**
ECSA No:	**200770044**	**ECSA No:**	**770358**

Design Engineer (Director) : PLP Consulting Engineers (Pty)ltd	**Director: PLP Consulting Engineers (Pty) Ltd**
	

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	Issued for Approval			
Date	2022.02.24			
Prepared by	V.Sambokwe			
Signature				
Quality Checked by	P.J Cronje			
Signature				
Authorised by	F.P Pieterse			
Signature				
Project number				

CLIENT APPROVALS

REVIEWED BY

JACO Theron
Senior Electrical Engineer (Principal Associate)

REVIEWED BY

ABONGI LE

4. Introduction

PLP Consulting Engineers (Pty)Ltd has been appointed by CSIR, Pretoria, as Professional Electrical Consulting Engineers to prepare the Preliminary Design for this project.

The data center up-stream existing electrical infrastructure consists of the following:

- 1 x 1000kVA transformer
- 1 x 1000kVA generator
- 1 x 25kA MLV board with change over MMCB's located in this board

The project aims at upgrading this infrastructure where the proposed arrangement will be as follows:

- Existing 1 MVA generator will be removed from the Data Center IT load, and two new generators will be installed as data center back up electrical supplies in an (N+1) redundancy scenario.
- Existing MLV board will be replaced with new, CSIR envision an almost maintenance free MLV board where the board will have online thermal scanning and some of the MCCB's will have micro logics to enable CSIR to monitor power quality and consumption alike further the new MLV board will feed the whole of Building 9 and the data center will have its own Distribution Board.
- All infrastructure will have early warning using the most appropriate technology where notification will be sent to CSIR maintenance personnel using SMS, messaging service, and or e-mails.

The Electrical Engineer from PLP Consulting will assist with broad planning, conceptualising and co-ordination of electrical engineering activities, including communicating with CSIR, other services providers (Contractors) and stakeholders, as and when appropriate.

The purpose of this Preliminary Design Report is to:

- Provides an overview of the electrical installations to be designed and installed for Building 9.
- To provide an overview of:
  - Proposed Infrastructure,
  - Site Condition,
- Proposed Technology to be applied for the LV Networks,
- The report evaluates the design parameters and design assumption,
- Detailed BOQ's and Cost estimate.

SUMMARY OF ELECTRICAL INSTALLATIONS

The Electrical installation includes the following major elements:

- 2 x Generators (N + 1) scenario,
- 2 x ATS Systems,
- MLV Distribution Board
- LV Cable reticulation to new MLV Board

ITEM	DESCRIPTION	COMMENTS
1.1	**DEMOGRAPHIC INFORMATION**	
Geo-graphical site Layout	Generator Co-ordinates:	
	• Building - 9	
	• MV Supply Point	Existing
Proposed Infrastructure		
	MV Reticulation	Existing
	LV Reticulation	Underground & LV Boards
Site Conditions	Soil type	Soft
	Climate	Temp: 0 to 35°C
1.2	**NETWORK INFORMATION**	
1.2.1	MV Source	Existing 1 MVA Substation
1.2.2	Load for area (New Development)	Final phase: 350kVA
1.2.3	MV Cable and size (Existing)	PILC (70sq.mm)
1.2.4	LV Cable and Size (New)	2 x 95mm² 4 core XLPE cable
Associated Projects	LV Infrastructure	New LV Board Replacements and ATS (Automatic Transmission Switch)

4.1 MV SYSTEM

The building is current supplied with an existing 1 x 1000kVA, 11kV/400V Transformer and a 1 x 1MVA Generator that feed through a changeover panel to an existing LV Distribution Board (MDB9)

4.2 LV Network

The building is supplied via 6 x 70mm² PILC (70sq.mm) cables from the transformer to the existing Distribution Board (MDB 9). The existing MLV 9 Board will be replaced with a new one.

4.3. EMERGENCY POWER (DATA CENTRE)

New generators (N + 1) scenario located near the existing building will supply emergency power to the existing Data center only. The rest of the building will utilize their own existing generator for back-up.

The Normal supply will be fed from the existing 1000kVA Transformer to the Generator 1 ground mounted Change over panel (ATS). The output of Generator 1 Automatic Transfer Switch (ATS) will then feed Generator 2 Automatic Transfer Switch (ATS). The output of Generator 2 will then feed onto the new Data Center Distribution Board.

The standby diesel-driven generator will automatically start in the event of a power failure, the ground mounted automatic transfer switch (ATS) will automatically switch to generator supply to make live the Data Centre section only and take load. When the mains power returns the control system shall monitor the mains supply and once stable initiate the changeover back to mains supply. The Generator specialist will enable the generator to return to normal power with no-break. The generator shall then cool down and switch off and remain in
'Auto' mode.

Only critical alarms will shut down the generator sets, non-critical alarms will allow connection to a BMS system for action by the facilities department.

Prior to handover, the emergency power system will be fully tested for the automatic transfer and operation of equipment supplied. A training session and instructions will be provided to the appropriate facilities management staff.

See attached drawings for Single Line Diagrams

4.3.1 Total Data Centre Load

Base on information received through the metering load profile, the total load for the Data Centre is:

The current Total Load for Data Centre

Total kVA (S) = 132kVA

Load for additional equipment to be relocated to Data Centre Main Distribution Board

Fire Suppression system = 40A
Sunren server room = 60A
Computer Room Aircon DB(as per meetring) = 63kVA

Total kVA (S) = √3 x Vx I
= (1.732 x 60 x 400) + 63kVA
= 104.56kVA

TOTAL KVA REQUIRED FOR BUILDING 9
Based on anticipated Load for Data Centre UPS System of 250kVA (N+1) scenario

The total required Load is)

= (250 + 104.56)
= 354.56kVA

Total kVA (S) @ 1.25% Full load = *S x 1.25*
= *354.56 x 1.25*
= *443.20kVA*

Total kVA (S) with Diversity factor of 0.7 = *S x 0.7*
= *443.20 x 0.7*
= *310kVA*

Therefore, required kVA Load = 350kVA

The total parameters for the Generator set will be as follows:

kVA Rating = 350kVA

Voltage = 230/400V

kW Rating = 332.5kW

Power Factor = 0.95

Silent canopy which can stand outside with lockable doors

The fuel tank will have to form part of the main Generator base to avoid separate plinths for the unit. The tank shall have sufficient capacity to run the engine on full load for a period of 12 hours

4.3.2 EXISTING EMERGENCY POWER

The existing 1000kVA Emergency Generator will be used to supply the entire building 9 offices and lights excluding the Data Centre, Colling system, Fire suppression system and Sunren room.

The existing control gear for the generator will be upgraded and new drawings produces.

4.4 Distribution Boards

4.4.1 DISTRIBUTION PANELS

Distribution panels shall be manufactured according to the drawings and the General specification in this document. Panels shall be provided in the following locations:

The Distribution Boards to be maintenance free MLV board where the board will have online thermal scanning and some of the MCCB's will have micro logics to enable Client to monitor power quality and consumption alike further the new MLV board will feed the whole of building 9 excluding the Data center which will have a separate DB with similar requirements.

All infrastructure will have early warning using the most appropriate technology where notification will be sent to CSIR maintenance personnel using SMS, messaging service, and or e-mails.

- 1 x Main LV Distribution Board (MDB 9)
- 1 x DATA CENTRE Distribution Board

Drawings of DB's, showing the proposed lay-out of equipment, must be submitted to the Engineer for approval, before manufacturing commences.

Busbars must be positioned to allow for cable entry from the Top and bottom. All bus bars must be tinned and rated according to the main circuit breaker and allows for 25% load increase.

Positions for spare equipment must be blanked off with blank clip-in cover or blank clip-in circuit breakers.

All boards must be inspected in the factory by the engineer before delivery.

All distribution panels and kiosks are to comply with the requirements of clause 6.6 of SANS 10142-1 (previously SABS 0124-1).

4.4.2 DOORS

Doors shall be of smooth flat finish suitably braced to ensure stiffness and recessed flush in the architrave. Catches shall be flush mounted.
Single doors shall not exceed the width of 0,6m.
All internal steelwork to be rust proofed, Powder coated, smooth finished and of colour as specified in the general specification.
All Exterior Steelwork to be of 3CR12 steel.

4.4.3 BUSBARS

Copper bus bars provided for each phase and neutral and marked in phase colours shall be mounted on insulators. Boards shall be suitably sized to accommodate, without undue cramping, all equipment.
A substantial brass earth bar, solidly bonded to the metalwork of the board, is to be provided with connectors for the incoming earth conductor and the earth wires of outgoing circuits.

4.4.5 MARKING AND LABELLING

Clearly engraved labels are to be mounted on or below every switch. The wording of the labels in one official language is to be according to the lay-out drawings or as directed by the engineer's representative and must be confirmed on site. Flush mounted board 2,0m above the finished floor level. Where relevant, 2,0m above the finished floor level. Where relevant, distribution boards shall conform to SABS 1180.

4.5 EQUIPMENT FOR DISTRIBUTION BOARDS

4.5.1 EARTH LEAKAGE RELAY (30mA): SINGLE OR THREE PHASE WITH ASSOCIATED CIRCUIT BREAKER.

The unit shall withstand fault currents (in accordance with SABS 156 of 2,5 kA or 6 kA, as required, between phase and earth, between phase and phase, or between phase and neutral without sustaining damage.

The circuit breakers shall be provided with overload trip coils and shall have a rupturing capacity of 2,5 kA or 6 kA as required, when tested in accordance with SABS 156.

The earth leakage unit must comply fully with SABS 767, as revised, and bear the SABS mark, equivalent to the ABB make.

4.5.2 MOULDED CASE CIRCUIT BREAKERS: (1A - 600A)

Circuit breakers shall be three pole housed in an insulating moulded chase and suitable for panel mounting. The circuit breakers shall comply with IEC 157-1 and SABS 156 and shall be similar or equivalent to the ABB compact systems suitable for standard performance levels (type N).

Circuit breakers shall be suitable for operation on supply voltages of 380/220V to 440/250V 50Hz, and the rupturing capacity at these voltages when the circuit breakers are tested in accordance with clause 7.10 of SABS 156 shall be as listed below for the various categories of circuit breakers.

The overload and short circuit trips of the circuit breaker may be of the following type:

(a) Combined thermal/magnetic trips with interchangeable trip units, the magnetic trip setting being adjustable.

(b) Combined thermal/magnetic trips with fixed and sealed trip units, the magnetic trip setting being adjustable.

The tripping times of the circuit breakers shall be in accordance with SABS 156.

The circuit breaker contacts are to be of silver alloy, and arc chutes or magnetic blow-outs must be provided.

The continuous current rating, trip rating and rupturing capacity of the circuit breaker shall be as stated in the directions for the service, and shall be one of the following categories covered by this specification: -

Normal Current	Rupturing capacity (@ 380/400V, AC) Symmetrical (current)	Equal and Similar to
500 - 1000 A	35kA	ABB
250 - 500 A	10kA	ABB
250A and less	15kA	ABB

4.5.3 TRIPLE POLE ON LOAD ISOLATORS WITHOUT TRIPS

The switches shall be of the triple pole, hand operated panel mounting, air break type, having continuous current ratings as indicated below, and suitable for operation on 330 - 440V, 50Hz systems.

The contacts are to be of 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.

The switches shall further be capable of being closed against faults and shall temporarily withstand the following system fault currents, until the associated circuit breakers operate:

Isolator rating 60A : Fault current 2 500A
Isolator rating 100A : Fault current 10 000A
Isolator rating 100A : Fault current 15 000A
Isolator rating 150A : Fault current 15 000A
Isolator rating 250A : Fault current 25 000A
Isolator rating 450A : Fault current 25 000A
Isolator rating 600A : Fault current 25 000A
Isolator rating 1000A : Fault current 25 000A

The switches are to be housed in moulded bakelite cases and are to be suitable for back of panel mounting.

To distinguish the switches from circuit breakers, to operating handles shall have a distinctive colour, preferably red and shall be indelibly marked “Isolator”.

5 Project Design

5.1 Complete Development Reticulation Diagrams

Annexure A - Proposed MDB 9 Single Line diagram
Annexure B - Data Centre Main DB Single Line diagram.
Annexure C - Generator Platform Layout Drawings

5.2 Building 9 - The spare capacity for the newly installed Generator and supply cable:

CSIR Supply	**350kVA/415V Free-Standing Generator, 486.94A TP**
Main Circuit LV Breaker	**500A TP, 15kA**
Existing LV Supply Cable before de-ration	**2 x 95mm^2 4 Core XLPE Copper with 2 x 95mm^2 BCEW, Current-Carrying Capacity = 2 x 258A = 516A**
Existing LV Supply after de-ration	**De-ration Factors: 2 x horizontal touching cables at 500mm deep = 0.81** **Ground thermal resistivity (K.m/W) = 1.2** **Depth of a cables = 0** **Ground Temperature at 25^{0}C = 1.00**
Total Calculated De-Ration	**The total de-ration factor = 1.2 x 0.81 = 0.972**
De-rated MV cable capacity	**De-rated cable capacity = 0.972 x 486.94A = 473.31A**

The Fault current for the Main distribution boards is less than 10kA and therefore the rating of the isolators and circuit breakers will have 5kA rating.

5.2.1 Voltage Drop Calculations for the Generator 95mm² Cable

METHOD A:

Cable Impedance = (Given Ω per km)/1000 x Cable length

Where cable impedance/km can be obtained from cable properties provided by manufacturers

Voltage Drop = Full Load Current x Cable Impedance

Where Full-Load current is obtained from Load Estimation

Percentage Voltage Drop = Voltage Drop /230V x 100

METHOD B:

Voltage Drop = 3ø or 1ø Volt Drop per Amp per metre

Where cable mV/A/m can be obtained from cable properties provided by manufacturers; Three-phase and Single-Phase figures can be chosen depending on the application

Percentage Voltage Drop = Voltage Drop /400V x 100

5.2.2 Volt Drop Calculations – Building 9 LV Cable

Voltage Drop Calculations building 9	Method A	Method B		Total Volt Drop	
Generator to LV Panel in Bld 9:					
From Generator (2 x 95mm^2 4 core XLPE cable)			V		
impedance	0.000246		Ω		
Voltage drop for 95mm^2	0.016	0.260	From book		
Full load Current	250	250	A		
Length of cable	65	65	m		
% Volt Drop	0.007	0.106	%	0.007%	0.106%

All Calculated Voltage drop are within the maximum voltage drop allowed by SANS 10142-1-2017 of 5%

6 SITE LOCATION AND DETAIL

SITE LOCATION

The site is located within the Tshwane Metropolitan Municipal area, adjacent the N1 and along Meiring Naude road situated in the Gauteng Province.

The following parameters are used in the design of the power supply system:

- Medium voltage three phase : 11kV
- Low voltage three phase : 415V
- Low voltage single voltage : 230V
- Mains power frequency : 50HZ

6.1 CONSTRUCTION PROGRAMME

The Contractor's programme shall be co-ordinated with the Engineer and CSIR and shall include allowance for adverse weather conditions, builders holidays and public holidays as specified by the PMT.

6.2 STORAGE

The Contractor shall provide adequate and safe storage for all materials. All materials shall be stored or stacked in positions that will not interfere with other work in progress in the area.

6.3 QUALITY OF MATERIALS

6.3.1 All materials supplied or utilised under this shall be new and unused. Only materials of first class quality and finish shall be utilised. All materials shall be subject to prior approval by the Engineer. The Engineer may in some cases require factory acceptance tests before delivery of material to site

6.3.2 All materials shall comply with the relevant SABS specifications.

All materials shall be unconditionally guaranteed for a period of 12 months from the date of practical completion, which is first hand over. Where Supplier's guarantees are of a shorter duration than 12 months, the Contractor shall unreservedly agree to the extension and cession of all warranties and guarantees.

6.3.4 The Contractor shall replace any materials that are found to be defective during the 12 months defects liability period.

6.4 COMPETENCE OF PERSONNEL, WORKMANSHIP AND STAFF

6.4.1 All work shall be executed and supervised by suitably qualified staff. Only "ACCREDITED PERSONS" shall be permitted to carry out and supervise work.

The Contractor shall at all times have an adequate number of employees available during the construction period to ensure that the work does not delay the construction programme.

6.4.2 The works shall be supervised by a full time registered "THREE PHASE ELECTRICIAN".

6.5 CO-ORDINATION OF SERVICES

The Contractor shall be responsible for the onsite co-ordination with the CSIR and other relevant Contractors. Allowance shall be made for this liaison and on-site co-ordination in the tender price.

6.6 FINISHING AND TIDYING

6.6.1 In view of the concentration of construction and other activities likely to be experienced during the Contract period, progressive and systematic finishing and tidying will form an essential part of this Contract. On no account will soil, rubble, materials, equipment or unfinished operations be allowed to accumulate in such a manner as to unnecessarily impede the activities of others. In the event of this occurring the Employer (CSIR) will have the right to withhold payment for as long as may be necessary in respect of the relevant Works in the area(s) concerned, without thereby prejudicing the rights of others to institute claims against the Contractor on the ground of unnecessary obstruction.

6.6.2 Finishing and tidying shall therefore not be left to the end of the Contract, but shall be a continuous operation.

6.7 EXISTING WORKS AND SERVICES

The Contractor is responsible for obtaining information regarding services and the existing works which may be affected by the new works. Before the Contractor commences operations, he must discuss with and have the approval of the Project manager (CSIR) concerned regarding the method he proposes to use for the safeguarding of any services and existing works he may encounter during construction. The cost of all precautionary measures, which may be necessary to ensure the safety of such services and existing works, as well as the protection of all persons, shall be borne by the Contractor. Any alteration to services, which may be required, shall be carried out by the Authority concerned at the expense of the Contractor. The Contractor shall be held responsible for any damage, injury or accident caused as a result of his failure to take the necessary precautionary measures.

6.8 SUPERVISION

Work shall at all times be subject to full time supervision by a qualified and experienced Site Agent. This representative must be authorised and competent to receive instructions on behalf of the Contractor.

6.9 PROTECTION OF OTHER SERVICES AND STRUCTURES

The Contractor shall take all the necessary precautions to protect existing services, finishes and structures during the execution of the Contract, and shall be fully responsible for all repairs and damages thereto. The costs for any repairs or damages shall be recovered from the Contractor.

The Contractor shall also exercise extreme care when excavations are made, to avoid damage to existing or newly installed services. Any damages to other services shall be rectified and the costs for the rectification will therefore be recovered from the contractor/subcontractor.

7 LV Reticulation Design

7.1 LV Internal Reticulation:

New LV Cables will be installed from the Transformer room to the new Generator plant position. All cables will be installed directly underground on a river sand bedding which will be suitable for this type of development.

- 4 x LV Cable specification: 600/1000V; XLPE Insulated PVC; SWA; Cu. complete with BCE wire as per specification.
- LV Cable sizes will be standardized as per CSIR requirement: 185sq.mm

All LV cables and earthing will be provided in accordance with the latest standards and specifications. The complete LV supply installation shall be handed over CSIR before the date of commissioning.

7.2 Design Parameters and Assumptions:

- Diversity factor : Three Phase, Single Phase – Balanced Network.

The following design parameters are applicable:

a) Medium Voltage:

- Supply voltage: - 0.415kV, 3-phase

b) Low Voltage:

- Loading (Building 9 MDB 9) - 230kVA
- Loading (Building 9 Data Center) - 132kVA
- Supply voltage - 415 Volt
- Regulation - +- 10%

7.3 Design Criteria

The Electrical Services will fulfil the following design criteria and configuration of all electrical networks and services:

- Adequate Capacity: load handling capabilities to meet present and future power requirements,
- Stability: the power supply must provide the necessary quality of supply under all environmental and power supply conditions, i.e. stability, voltage and frequency tolerances, interference free, etc.
- Reliability: under all circumstances,
- Adaptability: ability to cater for changes in future technology and without infrastructure modifications,
- Flexibility: simplicity of operation and ability to cater for changes in occupancy,
- Maintainability: ease of maintenance and totally serviceable with locally available components,
- Cost Effectiveness: minimized capital and long-term operational costs,

7.4 Earth Resistivity and Earthing

All MV and LV earthing will be provided in accordance with the Municipalities latest standard and specifications or similar.

As no earth resistivity tests have been carried out as yet, we are unable to give a clear picture on what earthing configuration will be used, but we expect that the Standard earthing configuration as per Local Municipality urban and CSIR reticulation (Underground cable networks) will be used

The contractor shall obtain the service of a specialist to do a complete survey on the site to obtain the resistivity readings for the different areas. From this the specialist shall do a detail design for the earthing and lightning protection installation which shall first be approved by the Consultant before installation. For this purpose a provisional amount is allowed in the bill of quantities.

7.5 Commissioning and Handing Over

All electrical internal services installed shall be handed over to the CSIR before the date of commissioning.

8. Bill of Quantities

Annexure F - Bill of Quantities and Cost estimate.

9. Generator and General Specification

9.1 Design standards and specification

Any relevant bulletins, specifications of material and standards required for successful completion of the project are also applicable:

The following parts of SANS 2001 and associated specification data are applicable:

- SANS 2001- BE1 Earthworks (general)
- SANS 2001- BS1 Site Clearance

Where the required information is not provided in the SANS 2001 documents, the following parts of SANS 1200 and associated specification data are applicable:

- SANS 1200 A - 1986 : General
- SANS 1200 C - 1980 (Amended 1982) : Site Clearance
- SANS 1200 D - 1988 (Amended 1982) : Earthworks

9.2 Applicable SANS Standards

Applicable SANS 10198 Standardised Specifications for the purpose of this Contract the latest issues of the following Standard Specifications for Electrical Engineering Construction, applicable at the date of Contract advertisement, shall apply –

- SANS 110198 (1 – 13) LV Cable selection, handling and installation
- SANS 10292 Earthing of low voltage distribution systems
- SANS 61238-1
- SANS 97
- SANS 0200
- SANS 1339
- SANS 97
- SANS 10198 (1 – 13)
- IEC 60298:1990
- NRS 003-1:1994 (3)
- Compression and mechanical connectors for power cables
- Electric cables
- Neutral earthing in MV systems
- Electric cables – XLPE
- Electric cables - PILC
- MV Cable selection, handling and installation
- AC Metal Clad – enclosed switchgear and control gear
- Metal Clad Switchgear
- VC 8075
- Compulsory specification for the safety of electrical cables

THE FOLLOWING STANDARDS OR EQUIVALENT RSA OR INTERNATIONAL STANDARDS SHALL APPLY AS APPROPRIATE:

- The National building regulations as amended

- SANS 10142-1 Wiring of premises
- SANS 10313 Earthing of structures
- SANS 10199 The design and installation of earth electrodes
- SANS 10313 The protection of structures against lightning
- SANS 10400 The application of the National Building Regulations
- SANS 1063 Earth rods and couplers
- SANS 1411 Materials of insulated electric cables and flexible cords
- SANS 1507 Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
- SANS 1574 Electric cables - Flexible cords and flexible cables
- SANS 61558 Safety of power transformers, power supply units and similar
- SANS 767 Earth leakage protection units
- NRS 016:1995, *Electricity distribution — Code of practice for the earthing of low-voltage distribution systems.*

OHS ACT

All legal requirements as stated in the OHS-act must be adhered to apart from the exemptions as in part 0 of the Distribution Standard.

- OHS Act Occupational Health and Safety Act 85 of 1993

9.3 GENERATOR – SPECIFICATION

SEE ATTACHED EMERGENCY GENERATOR SPECIFICATION

9.3.1 Chromadek Shelter and Paving surround Generators

The Contractor to excavate and build a Pitched Chromadek covered steel structures over the Generators to match existing on site and paving around the generator plinths positions. The shelter to be as indicated in the BOQ.

10. CIVIL WORKS

10.1 Generator Platform

The Contract shall construct the Generator plinths will Bund wall as indicated on drawings

10.1.1 SITE CLEARANCE

Clear and Grub

The area designated by the Engineer and cleared and grubbed will be measured to the nearest m². The grubbing of trees and tree stumps cutting of trunks and branches exceeding 0, 5m in girth in to transportable lengths, backfilling of cavities, transporting, and disposing of material thus cleared, grubbed, cut, and demolished.

10.1.2 EARTHWORKS

Remove topsoil to nominal depth 300mm, stockpile, and maintain
The rate shall cover the cost of removing topsoil to a nominal depth of 300mm, stockpiling, and preventing dust nuisance.

10.1.3 Restricted Excavation

All excavations will be considered as soft excavations (intermediate included). Hard rock excavations will only be if blasting, spilling, or wedging is required. Before commencing with hard rock excavations, the Contractor shall take levels of the rock profile of the entire area to be worked upon. For this purpose, the Contractor shall inform the Engineer at least forty-eight (48) hours before commencing with such work, of his intention to perform such work
Excavation rates will include shoring or battering of trenches which might be required for deep Excavations. Before commencing with hard rock excavations, the Contractor shall take levels of the rock profile of the entire area to be worked upon. For this purpose, the Contractor shall inform the Engineer at least forty-eight (48) hours before commencing with such work, of his intention to perform such work
Hard rock excavations will only be applicable if blasting, wedging and splitting is implemented

Excavations will be neat and clear of rubble, organic and inorganic material and excessive water will be pumped/removed or allowed to subside before backfilling and compaction commences
The founding layer of backfilled excavations will be in-situ material ripped and compacted to at least 90% mod AASHTO

10.1.4 Brick Type

All bricks shall comply with SANS 227 and shall be engineering units of class Face Brick Standards with a nominal compressive strength of 12 MPa

10.1.5 **FOUNDATIONS** :

To sizes and depths shown, 220 & 280 walls without adjacent trenches to have 700 x 250 conc. foundations. Concrete to be 30MPa strength. Reinforcing for various soil types as indicated.
CABLE TRENCHES

Shall be constructed by the Contractor as indicated on drawings.

10.2 SLEEVES

Shall be installed by the Contractor.

10.3 BRICK MANHOLES

Manholes shall be constructed by the Contractor as indicated on drawings.

11. CABLE TERMINATIONS & ENTRIES

(a) All cable entries shall be from below and cable terminals shall be provided with lugs appropriate to the cable specified, including bolts, nuts, plain washers and locknuts. These terminals shall be located within 150mm of the cable boxes or gland plates and approved copper riser connections shall be provided between the terminals and the associated fuse or circuit breaker.

(b) The armoring of all cables shall be earthed to the main earth busbar together with the bare copper earth conductor specified with that cable. The armoring shall be neatly bent back over the outer PVC sheath and clamped to the channel with a K-clamp together with a short strand of bare copper earth conductor. This bare copper conductor shall be of the same cross sectional areas as the one laid with the cable and shall be connected to the earth busbar.

11. GENERAL TO THE INSTALLATION OF CABLES

11.1 INSPECTIONS

A logbook with three copies per page shall be kept by the Electrical Contractor on the site, in which each part of the installation that has been inspected can be recorded after inspection and approval.

11.2 DAMAGE TO OTHER SERVICES

Before commencement of trench digging activities on any section of the cable routes the Contractor shall obtain plans from the Principal Contractor or from the Consulting Engineers indicating the position of existing services along the route. The Contractor shall exercise the utmost care when working in their vicinity. Machine excavation near existing services will only be to the extent permitted by the Engineer, and no additional payment will be made for the hand work entailed.

The Contractor shall assume full responsibility in case he or any person in his service is directly or indirectly responsible for any damages caused to other services already installed (water, sewerage, storm water, roads, surveyor's pegs, etc.) Any such damage shall immediately be reported to the Engineer or his representative.
The Contractor shall be held fully responsible for the repair of such damage to the satisfaction of the Engineer.
The cost for the repair of such damage shall be borne by the Contractor. Claims by the Contractor in this connection will not be considered.

11.3 MISCELLANEOUS

Cables shall be rolled off the cable drums in such a fashion that they do not turn, cannot be damaged mechanically and are not exposed to too high tensile stress. All High Voltage cables and the heavier Low Voltage cables shall be supported at sufficiently short distances during the entire installation process. Cable rollers shall be used to lay cable and suitable cable grips shall be used. Great care shall be taken that the cables are not grazed, stretched, or deformed in any manner. The cables shall as far as possible always be installed exactly straight and parallel to one another.

The terminations and through joints shall be capable of withstanding the same testing voltage as the rest of the cable.

Connection of cables to the switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear, are in the following positions.

No 1 conductor: left (red phase) [A]
No 2 conductor: centre (white phase) [B]
No 3 conductor: right (blue phase) [C]

The open end of each cable shall be sealed against the ingress of water by means of a suitable heat shrinkable end cap.

12. TESTING AND COMMISSIONING

The Contractor shall make allowance in his tender for the complete testing and commissioning of the installation. All tests shall be carried out in the presence of the Engineer or his representative and notice of the envisaged testing date shall be given at least ten days beforehand.

The Contractor shall make allowance in his tender for the supply of all instruments, materials and tests which will be required for the commissioning.

Should any part of the installation fail during a test, or should the equipment in the opinion of the Engineer not meet with the requirements, the Contractor shall replace, repair or correct such equipment at his expense, to the satisfaction of the Engineer.

The following tests shall be carried out:

12.1 LOW VOLTAGE INSTALLATION

Continuity tests to prove the correct connection and correct phase connection of all Low Voltage cables.

Continuity test to prove the earthing of all cable armouring and earthing conductors.

Should the Engineer have reason to believe that cables may be damaged, a pressure test shall be conducted on the armouring to determine the state of the PVC sheath.

Tests for 600/1000V cables as detailed in SABS 150 par. D-3 or equivalent for cables manufactured according to BS specification

12.2. INSPECTIONS

Inspections shall be conducted as follows, unless other arrangements are made by the Engineer.

a) After a specific section of trenching has been excavated the Contractor shall give the Engineer or his representative 24 hours' notice that he wants to install cable in this specific area.

The Engineer or his representative shall then inspect the trench and approve it in writing before cable can be installed in the trench by the Contractor. This inspection shall be carried out as soon as possible after receiving the mentioned notice from the Contractor.

b) After the trench has been approved, the Contractor can proceed to install cable in the trench. Only after the cable installation has been approved in writing can the trench be backfilled.

12.3. CERTIFICATE OF COMPLIANCE

On completion of the service, a certificate of compliance must be issued to the Engineer's Representative/Agent in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993).

13. EARTHING OF INSTALLATION

13.1. Main Earthing

The type of main earthing must be as required by the supply authority if other than the Engineers, and in any event as directed by the Engineer's representative, who may require additional earthing to meet test standards.
Where required an earth mat shall be provided, the minimum size, unless otherwise specified, being 1,0m x 1,0m and consisting of 4mm diameter hard-drawn bare copper wires at 250mm centres, brazed at all intersections.

Alternatively or additionally earth rods or trench earths may be required as specified or directed by the Engineer's authorised representative.

Installations shall be effectively earthed in accordance with the "Wiring Code" and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC installation.
Connection from the main earth bar on the main board must be made to the cold water main, the incoming service earth conductor, if any and the earth mat or other local electrode by means of 12mm x 1,6mm solid copper strapping or 16mm² stranded (not solid) bare copper wire or such conductor as the Engineer's representative may direct. Main earth copper strapping where installed below 3m from ground level, must be run in 20mm diameter conduit securely fixed to the walls.

All other hot and cold water pipes shall be connected with 12mm x 0,8mm perforated for solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 150mm centres. In all cases where metal water pipes, down pipes, flues, etc., are positioned within 1,6m of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

13.2. Connection

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilised for any other clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the end shall be tinned and lugged.

14. INSTALLATION DETAILS

14.1 CABLE SLEEVE PIPES

Where cables cross under roadways or walk ways and other services and where cables enter buildings, the cables shall be installed in suitable PVC sleeves.
The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

14.2 NOTICES

The Contractor shall issue all notices and make the necessary arrangements with Supply Authorities and other authorities as may be required with respect to the installation.

14.3 ELECTRICAL EQUIPMENT

All equipment and fittings supplied must be in accordance with the attached quality specification, suitable for the relevant supply voltage, and frequency and must be approved by the Engineer's representative.

14.4 DRAWINGS

The drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed.

The position of street lights may be influenced and must be established on site, prior to these items being built in.

14.5 SERVICE CONDITIONS

All plant shall be designed for the climatic conditions pertaining to the service.

14.6 EARTHING AND BONDING

The Contractor will be responsible for all earthing and bonding of the building and installation. The earthing and bonding is to be carried out strictly as specification and to the satisfaction of the Engineer's representative.

14.7 MAINTENANCE OF ELECTRICAL SUPPLY

All interruptions of the electrical supply that may be necessary for the execution of the work, will be subject to prior arrangement between the Contractor and the Engineer and the Engineer's representative.

14.8 EXTENT OF WORK

The work covered by this contract comprises the complete electrical installation, in working order, as shown on the drawings and as per this specification, including the supply and installation of all lamps and also the installation of such equipment.

15 POWER CABLES

The Contractor shall supply and completely install all distribution cables as indicated on the drawings, and listed in the Schedule of Cables.

The storage, transportation, handling and laying of the cables shall be according to first class practice, and the contractor shall have adequate and suitable equipment and labour to ensure that no damage is done to cables during such operations.

The cable-trenches shall be excavated to a depth of 1.2m deep below ground level and shall be 450mm wide for one to three cables, and the width shall be increased where more than three cables are laid together so that the cables may be placed at least two cable diameters apart throughout the run. The bottom of the trench shall be level and clean and the bottom and sites free from rocks or stones liable to cause damage to the cable.

The Contractor must take all necessary precautions to prevent the trenching work being in any way a hazard to the personnel and public and to safeguard all structures, roads, sewage works or other property on the site from any risk of subsidence and damage.

In the trenches the cables shall be laid on a 75mm thick bed of earth and be covered with a 150mm layer of earth before the trench is filled in.

All joints in underground cables and terminations shall be made either by means of compound filled boxes according to the best established practice by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits such as “Scotchcast”. Epoxy-resin joints must be made entirely in accordance with the manufacturer’s instructions and with materials stipulated in such instructions. Low tension PVCA cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed without delay.

The laying of cables shall not be commenced until the trenches have been inspected and approved. The cable shall be removed from the drum in such a way that no twisting, tension or mechanical damage is caused and must be adequately supported at intervals during the whole operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables.

Backfilling (after bedding) of the trenches is to be carried out with a proper grading of the material to ensure settling without voids, and the material is to be tamped down after the addition of every 150mm. The surface is to be made good as required.

On each completed section of the laid and jointed cable, the insulation resistance shall be tested to approval with an approved “Meggar” type instrument of not less than 500V for low tension cables.

Earth continuity conductors are to be run with all underground cables constituting part of a low tension distribution system. Such continuity conductors are to be stranded bare copper of a cross-sectional are equal to at least half that of one live conductor of the cable, but shall not be less than 4mm² or more than 70mm². A single earth wire may be used as earth continuity conductor for two or more cables run together, branch earth wire being brazed on where required.

15.1 LAYING, JOINTING AND MAKING OFF OF ELECTRICAL CABLES

[The requirements specified hereafter, are aimed essentially at high tension cable but are also valid for low tension cable, where applicable.]

1. The use of the term "Inspector", includes the engineer or inspector of the Engineer or an empowered person of the concerned supervising consulting engineer's firm.

2. No cable is to be laid before the cable trench is approved and the soil qualification of the excavation is agreed upon by the Contractor and inspector.

3. After the cable has been laid and before the cable trench is back-filled the inspector must ensure that the cable is properly bedded and that there is no undesirable material included in the bedding layer.

4. All cable jointing and the making off of the cables must only be carried out by qualified experienced cable jointers. Helpers of the jointers may not saw, cut, solder, etc. The cable and other work undertaken by them must be carried out under the strict and constant supervision of the jointer.

5. Before the Contractor allows the jointer to commence with the jointing work or making off of the cable (making off is recognised as half a joint) he must take care and ensure:

5.1 that he has adequate and suitable material available to complete the joint properly and efficiently. Special attention must be given to ensure the cable ferrules and cable lugs are of tinned copper and of sufficient size. The length of the jointing lugs must be at least six times the diameter of the conductor,

5.2 that the joint pit is dry and that all loose stones and material are removed,

5.3 that the walls and banks of the joint pit are reasonable firm and free from loose material which can fall into the pit.

5.4 that the necessary copper-dams or retaining walls are made to stop the flow of water into the joint pit,

5.5 that the joint pit is provided with suitable groundsheets so that the jointing work is carried out in clean conditions,

5.6 that the necessary tents or sails are installed over the joint pit to effectively avert unexpected rainfall and that sufficient light or lighting is provided,

5.7 that the necessary means are available to efficiently seal the jointing or cable end when an unexpected storm or cloudburst occurs, regardless of how far the work has progressed,

5.8 that the cables and other materials are dry, undamaged and in all respects are suitable for the joint work or making off,

5.9 that the heating of cable oil, cable compound, plumbers metal and solder is arranged that they are at the correct temperature when required so that the cable is not unnecessarily exposed to the atmosphere and consequently the ingress of moisture (care must be taken of overheating).

Flow temperatures of cable oil and compound must be determined with suitable thermometers. Cable oil and compound must not be heated to exceed the temperatures given on the containers and precaution must be taken to ensure that the tin is not overheated in one position. The whole mass must be evenly and proportionally heated. (Temperature of solder and plumbers metal may be tested with brown paper (testing time: 3 seconds). The paper must colour slightly - not black or burnt)

6. Before the paper insulated cables are joined, they must be tested for the presence of moisture by the cable jointers test. This consists of the insertion of a piece of unhandled insulated impregnated paper tape in warm cable oil heated to a temperature of 130 ± 5° C. Froth on the surface of the oil is an indication that moisture is present in the impregnated insulation and the amount of the froth gives an indication of the moisture present.

7. If the cable contains moisture or is found to be otherwise unsuitable for jointing or making of the inspector is to be notified immediately and he will issue the necessary instruction to cope with the situation.

8. The joint or making off of paper insulated cables must not be commenced during rainy weather.

9. Once a joint is in progress the jointer must proceed with the joint until it is complete and before he leaves the site.

10. The jointer must ensure that the material and his tools are dry at all times, reasonably clean and absolutely free from soil.

11. Relating to the jointing of the cable the following requirements apply:

11.1 all jointing must be carried out in accordance with recognised and tried techniques and comply strictly with the instructions given by the supplier of the jointing kit.

11.2 The cables must be twisted by hand so that the cores can be joined according to the core numbers. If necessary the cable is to be exposed for a short distance to accomplish this. Under no circumstances may the cores in a joint be crossed so as to enable cores to be joined according to the core numbers. If it is not possible to twist the bales so that the preceding requirement can be met, then cores are to be joined in the normal way without any consideration of the core numbers.

11.3 Normally the cables will have profile conductors. The conductors shall be pinched with gas pliers to form a circular section, bound with binding wire so that they do not spread, and then thinned before jointing.

11.4 Jointing ferrules, the length of which are at least 6 times the diameter of the conductors, must be slid over the conductor ends to be joined and pinched tightly. Then they are soldered by means of the ladle process whilst being pinched further closed. Use resin only as a flux. The slot opening in the ferrule must be completely filled, including all depressions. Remove all superfluous metal with a cloth dipped in tallow. Work during the soldering process must be from top to bottom. Rub the ferrule smooth and clean with aluminium oxide tape after it has cooled down to ensure that there are not any sharp points or edges.

NB: The spaces between the conductor strands must be completely filled by soldering process and must be carried out quick enough to present the paper insulation form burning or drying out necessarily.

11.5 After the ferrules have been rubbed smooth and clean, they and the exposed cores must be treated with hot cable oil (110°C) to remove all dust and moisture. These parts are to be thoroughly basted with the oil.

11.6 The jointer must take care that his hands are dry and clean before the joint is insulated. Also the insulating tape which is to be used must first be immersed in warm cable oil (110°C) for a sufficient period to ensure that no moisture is present.

11.7 After the individual cores have been installed they must be well basted with hot cable oil and again after the applicable separator and/or belt insulation tape is applied before the lead joint sleeve is placed in position.

11.8 The lead joint sleeve must be thoroughly cleaned and prepared before it is placed on the cable and must be kept clean during the whole jointing process. Seal the filling apertures of the sleeve with tape until the sleeve is ready for composed filling.

11.9 The plumbing joints employed to solder the joint sleeve to the cable sheath, must be cooled off with tallow and the joint sleeve is to be filled with compound while it is still warm. Top up continuously until the joint is completely filled to compensate for the compound shrinkage.

11.10 The outer joint box must be clean and free form corrosion. After it has been placed in position it must be slightly heated before being filled with compound. Top up until completely.

12. As far as cable and boxes are concerned the requirements as set out above are valid where applicable.

16. DECOMMISSIONING

The Contractor will be responsible for the decommission and removal of all redundant equipment relating to the Distribution Boards and as indicated in the BOQ after commissioning of the Generators. The equipment will be sold as scrap to the Contractor.

17. QUALITY ASSURANCE

The supplier shall be listed as an ISO 9001 company. The product supplied shall have a certificate of acceptance from the STS Association. All parts other than imported electronic components shall be locally manufactured with local labor and proof thereof shall be submitted on request. Only offers who are able to comply with the above requirements will be considered.

18. ENVIRONMENTAL

The equipment shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing at the site.
The ED offered shall operate normally at ambient temperatures in the range of -10 to 55 degrees Celsius (IEC 62053-21). The ED shall operate in conditions of humidity of 0 to 95% below 35 degrees Celsius and 0 to 75% above 35 degrees Celsius. It is expected that the environment will be corrosive.
The printed circuit board (PCB) of the ED shall be conformal coated as protection against insects, dust and humidity.
The housing of the ED shall be made of stable insulating fire retardant material and shall comply with classification IP51 but without suction in the meter (IEC 61036).

ANNEXURE A

PROPOSED MDB 9 DB SINGLE LINE DIAGRAM

ANNEXURE B

PROPOSED DATA CENTRE MAIN DB SINGLE LINE DIAGRAM

ANNEXURE C

GENERATOR PLINTH DETAILS AND LAYOUT

ANNEXURE D

GENERATOR EARHGRID LAYOUT

ANNEXURE E

GENERATOR PLINTH, DRAINAGE & CONTAIMENT DETAILS

ANNEXURE F

BILL OF QUANTITIES