

Assessment, Redesign of the existing Medium Voltage **Transformers** Switchgear at the CSIR

Template	Project No.
•	
Identifier:	HETM001
Purchase	0.4077.40
Order:	3437740
Authorisation	0040 40 44
Date:	2019.12.11
Revision	
Date:	

LO937

PROJECT NAME: Transformer Replacement with Miniature Substations

PURCHASE ORDER NUMBER: 1000732933

1. Executive Summary

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

Two existing Buildings 3 and 33 Transformers will be replace with Miniature substations

PLP Consulting Engineers (Pty)Ltd objective is to assist the CSIR Team with the Assessment and Redesigning of the existing Medium Voltage Transformers and construction monitoring and handover of the new proposed Miniature substation. 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:

CSIR. **Employer:**

Projects Manager: Chris Roos, Cell: (082) 533 8026, croos@csir.co.za)

3. Authorisation

Compiled B	y:	Approved E	Зу:
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)Itd

Director: PLP Consulting Engineers(Pty) Ltd

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 2 of 35

TABLE OF CONTENTS

- 1. EXECUTIVE SUMMARY
- 2. STAKEHOLDERS
- 3. AUTHORIZATION
- 4. INTRODUCTION
- 5. MV & LV RETICULATION DESIGN
 - 5.1 MV BULK SUPPLY
 - 5.2 MV & LV INTERNAL RETICULATION
 - 5.3 DESIGN PARAMETERS & ASSUMPTIONS
 - 5.4 SELECTION OF DESIGN ADMD
 - 5.5 DESIGN CRITERIA
- 6. PROPOSED TECHNOLOGY
 - 6.1 MEDUIM VOLTAGE NETWORK
 - 6.2 LOW VOLTAGE INSTALLATION
- 7. PROJECT DESIGN
 - 7.1 ELECTRICAL RETICULATION DIAGRAMS
 - 7.2 MV & LV RETICULATION DIAGRAMS
 - 7.3 BILL OF QUANTITIES
- 8. GENERAL SPECIFICATION
 - 8.1 DESIGN STANDARD AND SPECIFICATION
 - 8.2 APPLICABLE SANS STANDARDS
 - 8.3 MINIATURE SUBSTATION SPECIFICATION
 - 8.4 CABLE RETICULATION NETWORK
- 9. CIVIL WORKS
- 10. CABLE TERMINATIONS AND ENTRIES
- 11. GENERAL TO THE INSTALLATION OF CABLES
- 12. TESTING AND COMMISSIONING
- 13. EARTHING OF INSTALLATION
- 14. INSTALLATION DETAILS
- 15. POWER CABLES
- 16. DECOMMISSIONING
- 17. QUALITY ASSURANCE
- 18. ENVIRONMENTAL



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 3 of 35

ANNEXURE A

ANNEXURE B

ANNEXURE C

ANNEXURE D

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 4 of 35

4. Introduction

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

The CSIR main Campus has 5 medium voltage ring networks supplying a combination of thirty-one (31) 11kV mini-substations and substations. Due to the age of the transformers and certain tests carried out, it has become evident that certain transformers are at their end of life period. On the 11Kv side there is 2 Sub-Stations that have been identified.

- Building 3.
- Building 33.

The task order instructs the Service Provider to assist the CSIR Project Management Team (PMT) with the planning, conceptualising, design, construction preparation and monitoring and handover of the MV supply and Electrical Installation. The task will be executed according to the Standard Scope of professional Services associated with the delivery of a package. The Consultant will through this task:

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 MV supply and Electrical Control Installation for the proposed Miniature Substations will be guided by available Load Profiles and also the guide from CSIR FM Technical Department for the two Building 3 and 33 for the proposed infrastructure replacement.

The purpose of this Detail Design Report is to:

- Provides an overview of the electrical installations to be designed and installed for the two Buildings.
- To provide an overview of:
 - Proposed Infrastructure,
 - Site Condition,
- Proposed Technology to be applied for the MV & LV Networks,
- The report evaluates the design parameters and design assumption,
- Detail BOQ's and High Level Cost estimate.

SUMMARY OF ELECTRICAL INSTALLATIONS

The Electrical installation includes the following major elements:

- MV Supply Terminations,
- Miniature-substation,
- Primary LV reticulation to existing LV Boards,



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 5 of 35

ITEM	DESCRIPTION	COMMENTS
1.1	DEMOGRAPHIC INFORMATION	
	DEMOGRAPHIC INFORMATION Mini-Substations Co-ordinates: Building - 3 Building - 33 MV Supply Point MV Reticulation LV Reticulation Underground & Substations LV Reticulation Underground & Substations LV Reticulation Soil type Climate NETWORK INFORMATION MV Source Existing Substations Load for area (New Development) MV Cable and size MV/LV Substation Proposed Minia LV Board Repla	
	DEMOGRAPHIC INFORMATION Mini-Substations Co-ordinates: Building - 3 MV Supply Point MV Reticulation LV Reticulation Soil type Climate NETWORK INFORMATION MV Source Load for area (New Development) MV Cable and size MV Building - 33 Underground cables Substations Underground & LV E Soft Temp: 0 to 35°C Existing Substation MV Cable and size PILC (70sq.mm) MV/LV Substation Proposed Miniature in the seciated Projects LV Infrastructure	
Geo-graphical site		
	MV Supply Point	
Layout		
	MV Reticulation	Underground cables & Mini
Proposed Infrastructure		
'	LV Reticulation	Underground & LV Boards
	Soil type	Soft
Site Conditions	Climate	Temp: 0 to 35°C
1.2	NETWORK INFORMATION	
1.2.1	MV Source	Existing Substation
1.2.2	Load for area (New Development)	Final phase: 0.75MVA
1.2.3	MV Cable and size	PILC (70sq.mm)
1.2.4	MV/LV Substation	Proposed Miniature Substations
Associated Projects	LV Infrastructure	LV Board Replacements – Done by Others

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 6 of 35

4.1 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

4.2 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.

4.3 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.

4.4 QUALITY OF MATERIALS

- 4.4.1 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
- 4.4.2 All materials shall comply with the relevant SABS specifications.
- 4.4.3 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.
- 4.4.4 The Contractor shall replace any materials that are found to be defective during the 12 months defects liability period.

4.5 COMPETENCE OF PERSONNEL, WORKMANSHIP AND STAFF

- 4.5.1 All work shall be executed and supervised by suitably qualified staff. Only "ACCREDITED PERSONS" shall be permitted to carry out and supervise work.
- 4.5.2 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.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 7 of 35

4.5.3 The works shall be supervised by a full time registered "THREE PHASE WIREMANS LICENCE ELECTRICIAN".as Department of Labour requirements

4.6 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.

4.7 **FINISHING AND TIDYING**

- 4.7.1 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.
- 4.7.2 Finishing and tidying shall therefore not be left to the end of the Contract, but shall be a continuous operation.

4.8 **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.

4.9 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.

4.10 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.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 8 of 35

5. MV & LV Reticulation Design

5.1 MV Supply

Tshwane Metropolitan Municipality supplies CSIR with 132kV supply which is stepped down via two 15 MVA transformers to 11kV . CSIR provide their own 11kV reticulation network within their infrastructure

The Contractor is required to supply and install all required material and services as specified for the MV Electrical supply for this project.

The MV shall be obtained from an existing Cable network that feeds the two existing Buildings 3 and 33 within the premises of CSIR. The existing Building 3 and 33 will be equipped with new 11kV/415V Miniature Substation.

The MV supply will have sufficient transferring capability to cater for the existing loading and provision for future load growth for the two Buildings

Due to the nature of the area and the existing MV cable network lay-out and current loading , the new proposed Miniature Substations of 500 KVA and 250 kVA for building 3 and 33 respectively will be installed to replace the 3 x 250 kVA and 2 x250 kVA for building 3 and 33 respectively. The existing 11 kV cables will be re-routed from the existing indoor transformer rooms to the new positions of the Miniature substations.

MV Cable Substation specification:

Existing MV Cable supply - 11kV Cable; 70sq.mm; Cu.; PILC;

5.2 LV Internal Reticulation:

New LV Cables will be installed from the Mini-substations to the new LV switchboards. All cables will be installed directly underground on a river sand bedding which will be suitable for this type of development.

- 2 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.

5.3 Design Parameters and Assumptions:

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

The following design parameters are applicable:

- a) Medium Voltage:
 - Supply voltage: 11kV, 3-phase



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 9 of 35

b) Low Voltage:

Loading (Building 33)
Loading (Building 3)
Supply voltage
Regulation
500kVA
315kVA
415 Volt
+- 10%

5.4 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,

6. Proposed Technology

The MV & LV (Underground) cable network shall be installed or layed as per similar standards and specifications as specified and required by CSIR.

The electrical network shall be designed in accordance with the latest revisions and amendments of the following:

- · Tshwane Municipality By-Laws and Regulations,
- CSIR Electrical Reticulation Standards & Supply Methods.

Only readily available equipment supported locally with technical assistance and sufficient levels of stock for on-going maintenance will be specified.

6.1 Medium Voltage Network

The medium voltage reticulation network shall be at 11kV via underground 70sq.mm PILC, underground copper cables from the existing CSIR Stations to the new proposed Miniature substations strategically positioned.

The Existing 11kV underground cables shall be re-routed from the existing indoor transformer rooms to supply the 11kV/415V/230V low loss Miniature Substation strategically placed.

The Miniature substation shall transform the 11kV medium voltage to the normal operating low voltages of 415V three phase and 230V single phase



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 10 of 35

6.2 Low Voltage Installation

From the 11,000/400V Miniature Substations, two radial LV cables will be installed to each LV Boards. This is done to split the LV current flow.

N.B. LV Cable infrastructure shall be installed, layed and numbered in accordance CSIR Low Voltage Cable Distribution Standard and specifications or similar.

6.3 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.

6.4 Commissioning and Handing Over

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



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 11 of 35

7 Project Design

7.1 Complete Development Reticulation Diagrams

Annexure A - Proposed Single Line diagram

Annexure B - Building 3 Proposed Miniature Substations Positions.

Annexure C - Building 3 Proposed Miniature Substations Positions.

7.2 Building 3 - The spare capacity for the newly installed transformer (Mini-Sub) and supply cable:

CSIR Supply	500kVA 11000/415V Free-Standing Mini Substation, 696A TP
Main Circuit LV Breaker	800A TP, 20kA
Existing MV Supply Cable before de-ration	2 x 70mm ² 4 Core PILC Copper with 2 x 35mm ² BCEW,
	Current-Carrying Capacity = 2 x 195A = 390A
Existing MV Supply after de-ration	De-ration Factors: 2 x horizontal touching cables at
	500mm deep = 0.85
	Ground thermal resistivity (K.m/W) = 1.07
	Depth of a cables = 1.00 Ground Temperature at 25°C = 1.00
	Ground Temperature at 25°C = 1.00
Total Calculated De-Ration	The total de-ration factor = 0.85 x 1.07 x 1.00 = 0.9095
De-rated MV cable capacity	De-rated cable capacity = 0.9095 x 390A = 354.705A
New LV Supply Cable before de-ration	2 x 185mm ² 4 Core XLPE Copper with 2 x 95mm ² BCEW,
	Current-Carrying Capacity = 2 x 435A = 870A
New LV Supply after de-ration	De-ration Factors: 2 x horizontal touching cables at
	500mm deep = 1.0
	Ground thermal resistivity (K.m/W) = 1.2
	Depth of a cables = 0.87
	Ground Temperature at 25°C = 1.00
Total Calculated De-Ration	The total de-ration factor = 0.87 x 1.2 x 1.00 = 1.044
De-rated MV cable capacity	De-rated cable capacity = 1.044 x 870A = 908.28A
Connected Load	417A, 500kVA = 60% of the Mini sub Transformer Capacity
Mini Sub Transformer Spare Capacity	279A spare capacity = 200kVA = 40% of available
With connected MD of 417A	capacity
Cable Loading with MD of 417A	417A = 46% of 908.28A
Cable Spare capacity	491.28A = 54%



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 12 of 35

7.2.1 Volt Drop Calculations - Building 3 LV Cable

Voltage Drop Calculations building 3	Method A	Method B		Total V	olt Drop
Mini sub to LV Panel in Bld 3:					
From Minisub (2 x 185mm ² 4 core XLPE cable)	3.132	5.4288	V		
impedance	0.009		Ω		
Voltage drop for 185mm ²		0.260	From		
			book		
Full load Current	696	696	Α		
Length of cable	60	60	m		
% Volt Drop	1.3617	1.3572	%	1.362%	1.357%

7.3 Building 33 The spare capacity for the newly installed transformer 9Mini-Sub) and supply cable:

CSIR Supply	315kVA 11000/415V Free-Standing Mini Substation, 438A TP
Main Circuit LV Breaker	500A TP, 20kA
Existing MV Supply Cable before de-ration	2 x 70mm ² 4 Core PILC Copper with 2 x 35mm ² BCEW, Current-Carrying Capacity = 2 x 195A = 390A
Existing MV Supply after de-ration	De-ration Factors: 2 x horizontal touching cables at 500mm deep = 0.85 Ground thermal resistivity (K.m/W) = 1.07 Depth of a cables = 1.00 Ground Temperature at 25°C = 1.00
Total Calculated De-Ration	The total de-ration factor = 0.85 x 1.07 x 1.00 = 0.9095
De-rated MV cable capacity	De-rated cable capacity = 0.9095 x 390A = 354.705A
New LV Supply Cable before de-ration	2 x 185mm ² 4 Core XLPE Copper with 2 x 95mm ² BCEW, Current-Carrying Capacity = 2 x 435A = 870A
New LV Supply after de-ration	De-ration Factors: 2 x horizontal touching cables at 500mm deep = 1.0 Ground thermal resistivity (K.m/W) = 1.2 Depth of a cables = 0.87 Ground Temperature at 25°C = 1.00
Total Calculated De-Ration	The total de-ration factor = 0.87 x 1.2 x 1.00 = 1.044
De-rated MV cable capacity	De-rated cable capacity = 1.044 x 870A = 908.28A
Connected Load	230A, 315kVA = 52% of the Mini sub Transformer Capacity
Mini Sub Transformer Spare Capacity	120A spare capacity = 151kVA = 48% of available
With connected MD of 230A	capacity
Cable Loading with MD of 230A	230A = 25% of 908.28A
Cable Spare capacity	678.28A = 75%



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 13 of 35

7.3.1 Volt Drop Calculations - Building 33 LV Cable

Voltage Drop Calculations building 33	Method A	Method B		Total V	olt Drop
Mini sub to LV Panel in Bld 33:					
From Minisub (2 x 185mm ² 4 core XLPE cable)	1.575	2.73	V		
impedance	0.009		Ω		
Voltage drop for 185mm ²		0.260	From book		
Full load Current	350	350	Α		
Length of cable	60	60	m		
% Volt Drop	0.6848	0.6825	%	0.685%	0.683%

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



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 14 of 35

7.4 Bill of Quantities

Annexure D - Bill of Quantities and High level cost estimate.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 15 of 35

8. General Specification

8.1 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
 SANS 2001- BS1
 Earthworks (general)
 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

8.2 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)
 SANS 10292
 LV Cable selection, handling and installation
 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



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 16 of 35

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, Ele	ectricity distribution — Code of practice for the earthing of low-volta

 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

8.3 MINIATURE SUBSTATION - SPECIFICATION

The 11kV/415V Miniature Substation shall be fully equipped with all the items as per the general specification including SF6 Ring Main Unit. The mini-sub should come with capability of retrofitting the transformer up to 630kVA. The MV switchgear should come complete with SCADA (RTU) capabilities and further the protection used should be of relay type and not fuses.

On the 11kV there should be metering CT's installed in line with the requirements of NRS057 for this type of installation. The CT wiring should be complete, terminated and shorted out in the LV compartment.

The Miniature Substation must be placed on a pre-cast plinth with 110mm PVC pipes installed underneath the plinth 1m deep at the 11kV compartment for the installation of the 11kV cables.

The contractor shall make all arrangements and allowances to off-load the unit.

Guaranteed Technical Schedules shall be completed and submitted together with the tender offer

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 17 of 35

8.3.1 SCOPE

- 8.3.1.1 This specification covers the minimum requirements for the selection, manufacture, testing and supply of outdoor type miniature substations. It is applicable to medium-voltage substations for systems with AC rated nominal voltages 12 kV. This specification covers Type B miniature substations requirements not exceeding 630 kVA.
- 8.3.1.2 The tests prescribed in this specification will evaluate the performance capabilities of medium-voltage miniature substations.
- 8.3.1.3 The provisions of NRS 004 miniature substation requirements must be adhered to have been adopted, in order to ensure that quality miniature substations are purchased.

8.4 NORMATIVE REFERENCES

- 8.4.1 The following documents contain provisions that, through reference in the text, constitute requirements of this specification. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.
- 8.4.1.1 NRS 004 (Int): 2000: Mini-subs for rated A.C. Voltages up to and including 11kV.
- 8.4.1.2 **CP-TSSPEC-006 : 2002:** Specification for 11 kV metal-enclosed ring main units for type B miniature substations.
- 8.4.1.3 NRS 068 : 2002: Cable earth fault indicators.
- 8.4.1.4 SABS 555: 1985: Mineral insulating oil for transformers and switchgear (uninhibited).
- 8.4.1.5 **NRS 053 : 2000:** Accessories for Medium Voltage power cables (3,8/6,6kV to19/33kV)
- 8.4.1.6 **SABS 1339 : 2000:** Electric cable Crossed-link polyethylene (XLPE)- insulted cable for voltages from 3,8/6,6kV to 19/33kV.
- 8.4.1.7 **SABS 780 : 1998:** Distribution transformers
- 8.4.1.8 **BS EN 50180 : 1999:** Bushings above 1 kV up to 36 kV and form 250A to 3,15kA for liquid filled transformers

8.5 GENERAL

- 8.5.1 The transformer shall be approved in writing by the Consultant.
- 8.5.2 **No** refurbished miniature substations / 2nd hand will be accepted.
- 8.5.3 Miniature substation shall be installed, tested and commissioned to the Mbombela Local Council's standards, complete with base as specified further herein.
- 8.5.4 Only 11kV/415V, **315kVA TYPE B** and **500kVA TYPE B** miniature substation shall be used.
- 8.5.5 A 11kV Ring Main Unit with fuse-switch, a low loss wound distribution transformer, LV bus-bars and switchgear, small wiring, etc.
- 8.5.6 It shall be suitable for use at an altitude of 1000m above mean sea level in an area of high summer rainfall, and high humidity with severe lightning conditions and light winter frost.
- 8.5.7 The main supply to the LV compartments shall be metered by means of a Landis & Gyr, ZMD 405 CT meter installed with appropriate CT's and VT's.
- 8.5.8 To comply with the relevant SANS specification

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 18 of 35

8.6 ENCLOSURE

- 8.6.1 The housing shall be rectangular in plan, approximately 3 meters long by 1,2 meters wide (manufacturer's nearest standard). Colour shall be avocado code C 12.
- 8.6.2 The housing shall be of 2mm 3CR12 construction. The housing shall be erected on a rolled steel channel under base of 100 x 50mm, galvanised and Epoxy tar painted and shall be rigid, robust and completely self-supporting. All bolts and screws to be cadmium plated. The housing shall be so designed that it can be lifted off, complete with base frame, or lowered over a Ring Main Unit fixed to already connected HV cables.
- 8.6.3 The housing shall be vermin proof, dust and corrosion proof and shall protect the internal equipment from spray water or falling rain at an angel of 60 degrees to the vertical.
- 8.6.4 Adequate ventilation shall be provided to prevent the build up of condensation or heat in any compartment of the miniature substation.
- 8.6.5 The housing shall be divided to approval into four separate compartments for HV Switchgear, transformer, LV main circuit breaker and transformer accessories, LV Switchgear, busbars and metering. The switchgear compartment shall be provided with an approved hinged locking access doors. These doors shall exert uniform pressure at all points on the gasket when the door is closed and shall be adequately sized for the operation and maintenance of the equipment installed therein. All doors shall open from the outside. The locking handle on each door shall be such as to accept the Council's standard substation padlocks.
- 8.6.6 Each door shall be fitted with approved engraved aluminium danger signs to comply with the requirements of the Occupation Health and Safety act, Act 85 of 1993 as amended. Front and rear doors shall be provided to give access to the two HV cable end boxes.
- 8.6.7 All terminal and other current carrying conductors shall be shrouded or otherwise insulated.
- 8.6.8 Base of mini sub to be filled up with sand and covered with layer of screed.
- 8.6.9 Should comply with the explosion specification

8.7 CLEANING AND PAINTING

8.7.1 The metal shall be degreased and shot blasted to remove all dirt, scale or blemishes. It shall be powered coated in a approved fashion with one coat zinc chromate primer and two coats of scratchproof, weatherproof enamel, both on the inside and outside of the unit. The instrument/circuit breaker panel shall be painted white inside and the outside, including the roof, avocado green to SABS specification.

8.8 TRANSFORMER (TO SABS 780/1979)

- 8.8.1 The low loss transformer shall be of the indoor oil immersed type, filled with oil to SABS 555-1959, and shall be tested before the filling and dispatch of the transformer.
- 8.8.2 The winding shall be of plain annealed copper or copper foil or aluminium foil and the connections shall be of plain annealed copper conductors adequately insulated and braced to maintain clearances between other windings and between live parts and other metal parts when subjected to short circuit or earthed conditions, and to be free of vibration in normal service and during transport.

8.9 GENERAL SPCIFICATIONS

- 8.9.1 Noise levels Shall not exceed those laid down in SABS 780
- 8.9.2 Voltage Ratio 11kV/415V/242 V open terminal with earthed neutral
- 8.9.3 Vector group Dyn 11
- 8.9.4 Tappings on HV Windings $\pm 2,5\%$ and $\pm 5\%$
- 8.9.5 Tapping Adjustment By means of externally operated, off load lockable tap switch
- 8.9.6 The transformer shall be fitted with indoor bushings and terminal adapters suitable for the number and size of connections, both HV and LV cabling.
- 8.9.7 The tank shall be of the sealed non-breathing type incorporating 20% free space above the oil.
- 8.9.8 The transformer compartment shall be removable without disturbing HT or LT cabling.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 19 of 35

8.10 MEDIUM VOLTAGE EQUIPMENT

- 8.10.1 The high voltage equipment shall incorporate a Ring Main Unit rated 630A, 350 MVA for 3 seconds or similar equipment approved in writing by the Electrical Engineer, fitted with a suitable bracket with wooden clamping blocks, below terminals of switchgear, to clamp and support up to 120mm² PILCDSTA cable for a 315 KVA and up to 185mm² for 630 KVA and a tee-off fused switch. The unit shall incorporate cable earthing device and cable test connections behind and interlocked safety cover.
- 8.10.2 Test certificates to BS 116 and 3941 shall be provided for each unit.
- 8.10.3 Marking of conductors and terminals of power and secondary circuit to show phase sequence shall comply with BSS 158-1968. Busbar connections and risers shall be air insulated to BSS 169-1957.
- 8.10.4 Clearance from phases to earth and between phases to BSS 162.
- 8.10.5 A set of three (3) spare fuses per miniature substation shall be supplied. The 12kV fuses shall be complete with striker pins, rated at 35,5A and of the OEMFA type.
- 8.10.6 The Ring Main Unit shall face the end of the housing away from the transformer.
- 8.10.7 A spare set of fuses to be supplied by the developer / applicant prior to final hand over to Council.

8.11 LOW VOLTAGE EQUIPMENT

- 8.11.1 Bus-bars connections and risers suitably colour coded, shall be air insulated and conform to the latest SABS specification or failing that, the BSS 159 shall apply. Clearances between phases and phase to earth shall be adequate and busbar support insulators shall be of porcelain or epoxy resin mounding.
- 8.11.2 All connections from bus-bars shall be supported on insulators to maintain adequate spacing, and shall, like the bus-bars be of copper.
- 8.11.3 A LV Main Circuit Breaker 500A (3) pole LY603 MCCB suitably rated shall be fitted for protection between the LV transformer terminals and the LV busbars. (1000A for 630 KVA). All cable terminals shall be provided with lugs appropriate to the cable, bolts, nuts, plain washers and locknuts. This provision will be in the same compartment as the tap changer, oil purification outlets, sight glass, etc off the transformer.
- 8.11.4 The main LV breaker and its terminals will be covered by a suitable, tough, venting, heat and explosive resistant clear cover.
- 8.11.5 Outgoing circuits shall be provided for as follows:
- 8.11.5.1 All terminations shall be fixed to suitable terminations. The gland plate is to be mounted to a rail to allow positioning of the gland plate as required. The rail shall be so positioned that the hole in the gland plate for the cable is in line with the terminations of the circuit breaker, and shall be mounted to the top of the under base. The rail shall be of rugged construction to allow for the secure mounting of the gland plate.
- 8.11.5.2 All gland plates shall be drilled, treated and suitably covered. Four gland plates with the following hole sizes shall be provided; 50mm diameter hole for 315 KVA and 63 mm diameter for 630 KVA. One gland plate with four 25mm diameter holes shall be provided for streetlight cables. One gland plate with one 20 mm diameter hole shall be provided for the day light switch cable.
- 8.11.5.3 The mounting rack for outgoing feeder circuit breakers shall be drilled for four CBI (LY603 and JSO 150-600A) circuit breakers.
- 8.11.5.4 In the metering section there shall be provision for installation of six British Standard Footprint meters and installation of three 10 VA current transformers for each meter shall be provided for at the busbars or below the circuit breaker on a 3CR 12 mounting plate. This shall be a hinged panel.
- 8.11.5.5 Streetlight equipment shall be provided for, to the right on the mounting rack mentioned: 3 x 80A 230V GEC kWh meters, AC1 contactor, photocell and by-pass switch for 3ph streetlight circuit.
- 8.11.6 Fuses, when for power circuits, control circuits or lighting circuits shall be of the HRC cartridge type mounted in enclosed holders suitable for manual withdrawal. The fuses shall reduce the rupturing capacity of associated circuit to 2,5kA.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 20 of 35

8.12 METERING

8.12.1 All metering shall be done on the low voltage or approved in writing by the Electrical Engineer or his delegate.

8.13 CABLE TERMINATIONS & ENTRIES

- 8.13.1 All cable entries shall be from below and cable terminals shall be provided with lugs appropriate to the cable specified, 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.
- 8.13.2 The armouring of all cables shall be earthed to the main earth busbar together with the bare copper earth conductor specified with that cable. The armouring 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 section areas as the one laid with the cable and shall be connected to the earth busbar.

8.14 SOCKET OUTLET(16 AMP)

8.14.1 One 16 A 1 phase Socket outlet shall be installed in the LV compartment and shall be protected by a suitable fuse and earth leakage unit as prescribed by the code of practice SANS 10142-1. All live connections will suitably covered as in terms of the said code of practice.

8.15 EARTHING IN SUBSTATION

- 8.15.1 An approved copper earth bar not less than 25mm x 3mm in section shall be provided along the entire length of the miniature substation internally, to which all metal parts of switchgear, transformer and cable end box glands shall be connected.
- 8.15.2 The earth bar shall be drilled at each end and fitted with a 10mm diameter brass terminal bolt, nut and locknut. The earth bar shall be fitted with a removable link between the HV and LV compartments.

8.16 TESTING

8.16.1 The supplier shall supply copies of all test certificates covering works tests to SABS or to the relevant BSS where not provided for by the SABS.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 21 of 35

8.17 SPECIFICATION

SPECIFICATION FOR A 500 kVA MINI-SUB 11KV/415V, ACCORDING TO NRS 004, NRS 006, SANS 780 EQUIPPED AND WIRED AS FOLLOWS:

- 1. MAIN C/B 800A (3 x Phase) 25kA min
- 2. 11 kV SF6 OR VACUUM RING MAIN SWITCH IEC 60420, IEC 60265-1, IEC 60129 INSTALLED IN ARC VENTILATED KIOSK WITH CHIMNEY (Type AB for arc ventilation in a public area – to the top) ACCORDING TO MANUFACTURERS SPESIFICATION, EQUIPED WITH:
 - 6.1 2 x ONN-LOAD LINKS
 - 6.2 1x CIRCUIT BREAKER FOR THE MINI SUB TRANSFORMER
 - 6.3 PROTECTION RELAY (VIP 35 TYPE)
 - 6.4 CABLE BOXES FOR CONNECTION TO 3 x 70mm² CU XLPE CABLE
 - 6.5 VISIBLE EARTH WHEN SWITCHES ARE ON EARTH POSITION
 - 6.6 MOUNTING RACK FOR HEAT SHRINK CABLE TERMINATIONS TO 3 x 70mm² CU XLPE CABLES
- 3. AN 11 kV EARTH FAULT INDICATOR + CT FOR CONNECTION ON CABLE WITH 230 VOLT AUXILIARY
- 4. TRANSFORMER 500 kVA, 11000/415/240V DYN 11 WITH COPPER WINDINGS
- 5. OFF LOAD TAP SWITCH 5 POSITION ± 6%
- EARTH LEAKAGE 10kA + INDUSTRIAL PLUG + BULKHEAD IN EACH COMPARTMENT WITH SWITCHES
- 7. 3 x MD AMMETERS + CT's TO MEASURE THE TOTAL LT. LOAD. ONE ENERMAX METER FOR TOTAL LT LOAD FUSE PROTECTED WITH TEST BLOCK.
- 8. VOLTMETER FUSE PROTECTED
- 9. NEUTRAL AND EARTH BAR CONNECTED (95mm²)
- 10. MOUNTING RACK FOR LT CABLES
- 11. OIL FILLED
- 12. TEST CERTIFICATES FOR RMU, TRANSFORMER AND OIL INSIDE TRANSFORMER
- 13. OIL LEVEL INDICATOR
- 14. LABELING ON DOORS AND INSIDE LT COMPARTMENT
- 15. FOUR IN ONE SAFETY PROCEDURES INSIDE RMU COMPARTMENT MAIN DOOR
- 16. MANUFACTURED FROM STEEL, POWDER-COATED AVOCADO GREEN
- 17. ALL EQUIPMENT INCLUDING RMU & TRANSFORMER MUST BE NEWLY MANUFACTURED WITH THE RELEVANT SANS OR IEC MARK
- 18. ALL DOORS PAD-LOCKABLE
- 19. ALL LIVE PARTS IN THE LT COMPARTMENT MUST BE COVERED TO AVOID ANY INADVERTENT CONTACT WHEN ANY CUBICLE DOOR IS OPENED. (IE. CIRCUIT BREAKER COVERS AND THE ENCLOSURE OF ALL CURRENT-CARRYING EQUIPMENT.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 22 of 35

SPECIFICATION FOR A 315 kVA MINI-SUB 11KV/415V, ACCORDING TO NRS 004, NRS 006. SANS 780 EQUIPPED AND WIRED AS FOLLOWS:

- 1. MAIN C/B (500AMP) (3 x Phase) 25kA min
- 2. 11 kV SF6 OR VACUUM RING MAIN SWITCH IEC 60420, IEC 60265-1, IEC 60129 INSTALLED IN ARC VENTILATED KIOSK WITH CHIMNEY (*Type AB for arc ventilation in a public area to the top*) ACCORDING TO MANUFACTURERS SPESIFICATION, EQUIPED WITH:
 - 6.1 2 x ONN-LOAD LINKS
 - 6.2 1x CIRCUIT BREAKER FOR THE MINI SUB TRANSFORMER
 - 6.3 PROTECTION RELAY (VIP 35 TYPE)
 - 6.4 CABLE BOXES FOR CONNECTION TO 3 x 70mm² CU XLPE CABLE
 - 6.5 VISIBLE EARTH WHEN SWITCHES ARE ON EARTH POSITION
 - 6.6 MOUNTING RACK FOR HEAT SHRINK CABLE TERMINATIONS TO 3 x 70mm² CU XLPE CABLES
- AN 11 kV EARTH FAULT INDICATOR + CT FOR CONNECTION ON CABLE WITH 230 VOLT AUXILIARY
- 4. TRANSFORMER 315kVA, 11000/415/240V DYN 11 WITH COPPER WINDINGS
- 5. OFF LOAD TAP SWITCH 5 POSITION ± 6%
- 6. EARTH LEAKAGE 10kA + INDUSTRIAL PLUG + BULKHEAD IN EACH COMPARTMENT WITH SWITCHES
- 7. 3 x MD AMMETERS + CT's TO MEASURE THE TOTAL LT. LOAD. ONE ENERMAX METER FOR TOTAL LT LOAD FUSE PROTECTED WITH TEST BLOCK.
- 8. VOLTMETER FUSE PROTECTED
- 9. NEUTRAL AND EARTH BAR CONNECTED (95mm²)
- 10. MOUNTING RACK FOR LT CABLES
- 11. OIL FILLED
- 12. TEST CERTIFICATES FOR RMU, TRANSFORMER AND OIL INSIDE TRANSFORMER
- 13. OIL LEVEL INDICATOR
- 14. LABELING ON DOORS AND INSIDE LT COMPARTMENT
- 15. FOUR IN ONE SAFETY PROCEDURES INSIDE RMU COMPARTMENT MAIN DOOR
- MANUFACTURED FROM STEEL, POWDER-COATED AVOCADO GREEN
- 17. ALL EQUIPMENT INCLUDING RMU & TRANSFORMER MUST BE NEWLY MANUFACTURED WITH THE RELEVANT SANS OR IEC MARK
- 18. ALL DOORS PAD-LOCKABLE
- 19. ALL LIVE PARTS IN THE LT COMPARTMENT MUST BE COVERED TO AVOID ANY INADVERTENT CONTACT WHEN ANY CUBICLE DOOR IS OPENED. (IE. CIRCUIT BREAKER COVERS AND THE ENCLOSURE OF ALL CURRENT-CARRYING EQUIPMENT.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 23 of 35

8.18 Chromadek Shelter and Paving surround to Mini-Substation Bases

The Contractor to excavate and build a Pitched Chromadek covered steel structures for each Mini-substation to match existing on site and paving around the Mini-Substation positions. The shelter to be as indicated in the BOQ. for each Mini-substation

8.19 THE CABLE RETICULATION NETWORK

The cable reticulation network shall be installed as per the layout drawings and the general specification. The cables shall be installed neatly using cable Sleeves underneath the paving as indicated on the drawings for different sleeve sizes.

Care shall be taken when installing cables from the Miniature substations to the LV Board Units. Cable manholes and sleeves shall be installed in such a manner that they do not interfere with other services. When pricing the tender, the tenderer shall take into account all these items in the price in order to make the installation fully functional. The contractor shall assure that the installation is as neat as possible.

9. CIVIL WORKS

9.1 CABLE TRENCHES

Shall be constructed by the Contractor as indicated on drawings.

9.2 SLEEVES

There will be no sleeves

9.3 BRICK MANHOLES

There will be no manholes.

10. 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 Kclamp 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.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 24 of 35

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.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 25 of 35

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).



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 26 of 35

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 <u>all cases</u> 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. Ring Mains

Common earth conductors may be used where various circuits are installed in the same wire way in accordance with SABS 0142. In such instances the sizes of earth conductors shall be equivalent to that of the largest current carrying conductor installed in the wire way, alternatively the size of the conductor shall be as directed by the Engineer. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

13.3. 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.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 27 of 35

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.



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 28 of 35

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.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 29 of 35

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

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 30 of 35

- 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.

DETAIL DESIGN DOCUMENT

Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 31 of 35

- 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 Transformer and as indicated in the BOQ after commissioning of the Minisubstations. 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).



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 32 of 35

ANNEXURE A

TECHNICAL SCHEDULES A and B



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 33 of 35

ANNEXURE B

BUILDING 3 PROPOSED MINIATURE SUBSTATION POSITION



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 34 of 35

ANNEXURE C

BUILDING 33 PROPOSED MINIATURE SUBSTATION POSITION



Assessment, Redesign of the existing Medium Voltage Transformers and Switchgear at the CSIR

Page 35 of 35

ANNEXURE D - BILL OF QUANTITIES

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES PRELIMINARY AND GENERAL CHARGES



ТЕМ	DESCRIPTION	UNIT	QTY	RATE		TOTAL
				MATERIAL	LABOUR	
	FIXED CHARGE ITEMS					
1.1	GENERAL					
	Preliminaries and general required to comply with the conditions of contract and all regulations governing this contract	Sum	1			
1.2	Site establishment and de-establishment	Sum	1			
1.3	OCCUPATIONAL HEALTH & SAFETY					
	Allowamce for Compliance with Construction Regulations, as detailed in Occupational Health & Safety Act (OHS), Act 85 of 1993, Submission of a (OHS) plan and all applicable documentation, to the client's satisfaction	Sum	1			
1.4	PERMITS AND NOTICES					
	Allow for obtaining all necessary permits and giving of notices and co-operation with other Trades	Sum	1			
1.5	DEFECTS LIABILITY					
	Allow for a defects liability period of 12 months against defects in Equipment, Material and Workmanship as set out elsewhere, but excluding abuse, wear and tear and normal maintenance.	Sum	1			



ITEM	DESCRIPTION	UNIT	QTY	R/	ATE	TOTAL
				MATERIAL	LABOUR	
	TIME RELATED ITEMS					
1.6	STORAGE					
	Provide for storage of Plant, Equipment and Material on site including protection and insurance					
	thereof	Mnth	3			
	SUPERVISION					
	Allow for qualified site supervision during the construction period	Mnth	3			
		-				
1.8	TRANSPORT	_				
	Allow for transport cost during the construction period	Mnth	3			
1.9	OTHER TIME RELATED ITEMS					
	Specify and cost all other time related items	-				
	not listed elsewhere as well as the period for					
	which these items will be applicable					
	Construction Guarantee	Sum	1			
1.10	PROVISIONAL AMOUNTS					
	Allow for a Provisional Amount for the works					
	to be used as directed by the Engineer for					
	items not allowed for in the Bill of Quantities					
	Provisional Amount for Day works					
	Allow for Procurement, Transport to site and	Sum	1			
	Profit:12%					
	(Tenderer to indicate profit margin and price					
	accordingly to day works amount)					
1.2	ADDITIONAL ITEMS					
ļ	Any additional Items that the tenderer would wish to specify and not listed elsware	_				
ļ		1				
1.2.1	Allowance for Factorty Acceptance Test (FAT) to include Client Representative and Engineer	Sum				
1.2.2		Sum				
1.2.3		Sum				
1.2.4		Sum				
1.2.5		Sum				
ļ		_				
Į.						

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES

CABLES AND CONDUCTORS



М	DESCRIPTION		QTY	R/	TOTAL	
				MATERIAL	LABOUR	
2.1	MEDIUM VOLTAGE CABLES (MV) TERMINATIONS - Building 3					
	For the delivery to site, supply and installation of 11kV Three Core Cables, Terminations and Joints for PILC Cable, as per specification.					
.1.1	Contractor to allow for Tracing of existing 11kV PILC Cable	ea	1			
2.1.2	Disconnect existing PILC 11kV, 3 core Cable and reroute to New Mini-sub position	m	80			
2.1.3	Terminations for 70mm² x 3 Core, PILC	ea	3			
2.1.4	Preparation kits for above terminations, complete with screened connectors.	ea	3			
2.2	Bare Copper Earth Wire installed with cable.					
	For the supply and instalation of the following BCEW with the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
2.2.1	35mm² CU bare earth wire, complete with joints.	m	80			
2.2.2	Terminations for the 35mm² CU bare earth wire	Ea	2			
2.3	LV Cable Terminations - Building 3					
	For the supply, installation and Testing of the following terminations for the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
2.3.1	Supply 185mm², XLPE, 3-Core CU, FRPVC, SWA, PE Cable	Ea	180			
2.3.2	Terminations for 2 x 185mm² x Three Core, PILC	Ea	12			
2.3.3	Preparation kits for above terminations, complete with screened connectors.	Ea	12			
2.3.4	Complete Installation & Commissioning of the 500kVA Mini-Substation	Ea	1			
2.4	Bare Copper Earth Wire installed with cable. For the supply and installation of the following BCEW with the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
2.4.1	95mm² CU bare earth wire, complete with joints.	m	180			
2.4.2	Terminations for the 95mm² CU bare earth wire	ea	2			

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES CABLES AND CONDUCTORS BILL NO. 2



М	DESCRIPTION	UNIT	QTY	R/	ATE	TOTAL
				MATERIAL	LABOUR	
2.4	GROUND WORKS FOR BUILDING 3					
	The Contractor shall do the setting out, excavation, removal of excavated material and backfilling of the					
	following trenches:					
4.1	GROUND WORKS FOR MV CABLES					
4.2	Excavate 1m deep x 450mm wide x 80m length in trenches	/m³	30			
	Bedding as per specification	m³	27			
	Backfilling and compaction of excavated trenches	/m	30			
	Lay 70mm², 11kV, PILC, CU, FRPVC, SWA, PE Cable	m				
4.5	Terminations for 70mm² x 3 Core, PILC	Ea	80			
4.6	Preparation kits for above terminations, complete with screened connectors.	Ea	6			
4.7	35mm² CU bare earth wire, complete with joints.	m	6			
4.8	Terminations for the 35mm² CU bare earth wire	Ea	80			
4.9	Cable pressure Testing	Ea	2			
.10	Case process recting		1			
2 5	GROUND WORKS FOR LV CABLES	m				
5.1	Excavate 1m deep x 450mm wide x 80m length in trench	/m³	36			
	Bedding as per specification Lay 2 x 185mm², 11kV, XLPE, CU, FRPVC, SWA, PE Cable	/m	36			
5.3	Terminations for 70mm² x 3 Core, PILC	/m	180			
5.4	Backfilling and compaction of excavated trench	ea	6			
5.5	Cable pressure Testing	/m³	27			
5.6						
5.7	Cable route markers	Ea	3			
5.8	Cutting of concrete walk way/ crossings	m³	1			
2.6	Rehabilitation of groundworks					
	For the rehabilitation of groundworks where the contractor excavated through existing paved areas, gardens, road					
	crossings etc.	sum	1			

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES

CABLES AND CONDUCTORS



ЕМ	DESCRIPTION	UNIT	QTY	RATE		TOTAL
				MATERIAL	LABOUR	<u> </u>
3.1	MEDIUM VOLTAGE CABLES (MV) TERMINATIONS - Building 33					
	For the delivery to site, supply and installation of 11kV Three Core Cables, Terminations and Joints for PILC Cable, as per specification.					
3.1.1	Contractor to allow for Tracing of existing 11kV PILC Cable	ea	1			
3.1.2	Disconnect existing PILC 11kV cable, Cut and joint existing Cable with new 11kV, 3 core PILC Cable	m	65			
3.1.3	Supply 70mm², 11kV, PILC, CU, FRPVC, SWA, PE Cable	м	65			
3.1.4	Terminations for 70mm² x 3 Core, PILC	ea	6			
3.1.5	Preparation kits for above terminations, complete with screened connectors.	ea	6			
3.1.6	Through Joint (3ph) for the above PILC, MV cable	ea	1			
3.2	Bare Copper Earth Wire installed with cable.					
	For the supply and instalation of the following BCEW with the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
3.2.1	35mm² CU bare earth wire, complete with joints.	m	65			
3.2.2	Terminations for the 35mm² CU bare earth wire	m	2			
3.3	LV Cable Terminations - Building 33 For the supply, installation and Testing of the following terminations for the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
3.3.1	Supply 185mm², XLPE, 3-Core CU, FRPVC, SWA, PE Cable	m	130			
3.3.2	Terminations for 2 x 185mm² x Three Core, PILC	Fa	12			
3.3.3	Preparation kits for above terminations, complete with screened connectors.	Ea	12			
3.3.4	Complete Installation & Commissioning of the 315kVA Mini-Substation	Ea	1			
3.4	Bare Copper Earth Wire installed with cable.					
	For the supply and instalation of the following BCEW with the 4 Core PVC insulated PVC Bedded SWA PVC sheathed 600/1000V copper cables as specified.					
	95mm² CU bare earth wire, complete with joints.		420			
3.4.1	Terminations for the 95mm² CU bare earth wire	ea	130			
2		ea	2	l	l	<u> </u>

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES CABLES AND CONDUCTORS BILL NO. 3



м	DESCRIPTION	UNIT	QTY	R/	RATE	
				MATERIAL	LABOUR	
3.4	GROUND WORKS FOR BUILDING 33					
0.4	The Contractor shall do the setting out, excavation, removal of excavated material and backfilling of the following trenches:					
4.1	GROUND WORKS FOR MY CABLES					
4.2	Excavate 1m deep x 450mm wide x 65m length in trenches	/m³	30			
4.3	Bedding as per specification	m³	27			
4.4	Backfilling and compaction of excavated trenches	/m³	30			
4.5	Lay 70mm², 11kV, PILC, CU, FRPVC, SWA, PE Cable	m	65			
4.6	Terminations for 70mm² x 3 Core, PILC	m	6			
4.7	Preparation kits for above terminations, complete with screened connectors.	Ea	6			
4.8	Through Joint (3ph) for the above PILC, MV cable	Ea	1			
4.9	35mm² CU bare earth wire complete with joints	m	60			
.10	Terminations for the 35mm² CU bare earth wire	Ea	2			
.11	Cable pressure Testing	Ea	1			
3.5	GROUND WORKS FOR LV CABLES Excavate 1m deep x 450mm wide x 65m length in trench	-				
5.1	Excavate 1111 deep x 450111111 wide x 65111 length in dentiti	/m³	30			
5.2	Bedding as per specification	m³	27			
5.3		m	180			
5.4	Terminations for 2 x 185mm² x 3 Core, CU,FRPVC, SWA, PE Cable	ea	12			
5.5	Backfilling and compaction of excavated trench	/m³	41			
5.6	Cable pressure Testing	ea	2			
5.7	Cable route markers	Ea	2			
5.8	Cutting of concrete walk way/ crossings	m³	2			
	<u> </u>		_			
3.6	Rehabilitation of groundworks					
	For the rehabilitation of groundworks where the contractor excavated through existing paved areas, gardens, road					
	crossings etc.	sum	1			

CSIR TRANSFORMER REPLACEMENTS
BILL OF QUANTITIES AND SUMMARY OF PRICES
SLEEVES
BILL NO. 4



TEM	DESCRIPTION	UNIT	QTY	RATE		TOTAL
				MATERIAL	LABOUR	
4.1	SLEEVING					
	For the supply and installation of the following sleeves					
	110mm dia sleeves in trench	m	100			
4.1.2	50mm dia sleeves in trench	m	0			
	(Unit prize required for each item)					

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES EARTHING, BONDING AND LIGHTNING PROTECTION



ITEM	DESCRIPTION	UNIT	QTY	RA	TE.	TOTAL
				MATERIAL	LABOUR	
5.1	Earthing and lightning protection:					
	Measuring of earth resistance by an earthing specialist and issuing of a report					
5.1.1	Measuring of earth resistivity over the site	Sum	1			
5.1.2	Issuing of a report	Sum	1			
5.2	Earthing and lightning protection:					
	Design, supply and install lightning protection and earthing system as per general and detail specifications document.					
5.2.1	Design supply and installation of the full earthing system for the site	Sum	1			
	Design supply and install a complete earthing and lightning protection system for the building based on SANS 10199/ 10313/ 62305 and IEC 62305	Sum	1			
5.2.3	Issuing of earthing Certificates	Sum	1			

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES BULK ELECTRICAL EQUIPMENT



ITEM	DESCRIPTION	UNIT	QTY	RATE		TOTAL
				MATERIAL	LABOUR	
6.1	ELECTRICAL EQUIPMENT					
	This is the bill to cover the supply, delivery installation, testing, cable termination and commissioning of all electrical equipment required for the Main Electrical supply as per Design Specification supplied. Detailed specification to be supplied for all equipment offered. Contractor to indicate period for Warranty and Gaurantee as per supplied Techical Schedules A and B					
Ī	500kVA 11000/415V TYPE B MINISUB COMPLETE WITH RM6 SF6 RING MAIN UNIT (Schedule A and B to be submitted with Tender)	each	1			
	315kVA 11000/415V TYPE B MINISUB COMPLETE WITH RM6 SF6 RING MAIN UNIT (Schedule A and B to be submitted with Tender)	each	1			
6.1.3	MINISUB-Pre-cast Plinth	Sum	2			
6.1.4	All notices and signs as per the OHAS act	Sum	1			

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES BULK ELECTRICAL EQUIPMENT



TEM	DESCRIPTION	UNIT	QTY	RA	RATE		TOTAL
				MATERIAL	LABOUR		
7.1	Chromadeck Shelter						
	This is the bill covers the supply, delivery, installation of Chromadek Shelter and Paving surround to Mini- Substation Bases and finishes						
	Chromadek Shelter and Paving surround to Mini-Substation Bases: Pitched Chromadek covered steel structures						
7.1.1	to match existing on site, 3.3 x 5.2m, maximum 3m high.	each	2				
	Excavation: Excavate in soft soil 3.5m x 5.5m wide x 150mm deep. Excavated soil, grass and plants to be	m³	8				
7.1.2	removed off site, to a legal dumping site.						
	Sub Base Compaction of ground surface under paving includes scarifying for a depth of 150mm, breaking down oversize material where necessary, areas opened deeper than 150mm (move services) to be completely opened and backfilled/compacted in layers of not more than 150mm. Stabilize with 3% cement (50kg/8m²) dampen and compact to 95% Mod AASHTO density, all to be weed and insecticide treated.						
7.1.3		Sum	2				
	Bedding Layer						
	Spread and level clean river sand bedding, 30mm thick after compaction. Paving Blocks (14m²/mini-sub)	m³	1				
7.1.0	'infraset' 50mm Cottage Stone concrete paving blocks (to match existing) laid with bevel face down, in brick bond pattern. Paved areas edges to be finished with a full header course, all sides. Compact and sweep clean plaster-sand/cement mixture into joints between blocks, wet remainder of mix, vibrate wet mixture with plate compactor in to joints, hose down with clean water.	m²	35				
716	Kerbing (17lm/mini-sub)						
7.1.0	KC31 Type light duty concrete kerbing to garden/lawn side of pathway, on min. 50mm concrete base, laid with 10mm perps between kerbing sections, perbes to be grouted with dagga and properly cleaned, leave open purbes @5m c/c. To allow for expansion. Provide unreinforced concrete haunching at back of each joint. Top of kerbing installed level with lawn and paving surfaces, 1m lengths used on straight sections and 300mm sections used on curved sections smaller than 5m radius.	m	36				
	Landscaping: Direct surroundings of new pathway, levels to be adjusted to not exceed 1:12 gradient, level						
7.1.7	and reinstate lawn by using existing removed lawn, stockpiled for reuse	sum	2				
	Builders Rubble: Remove all redundant rubble from site and move to legal dumping site.		 				40.00-
7.1.8	Chromadek Shelter (Allow provisional sum of R 20 000.00/mini sub)	sum	2			R	40,000.0

CSIR TRANSFORMER REPLACEMENTS BILL OF QUANTITIES AND SUMMARY OF PRICES



ITEM	DESCRIPTION UNI	UNIT	QTY	RATE		TOTAL
				MATERIAL	LABOUR	
8.1	DECOMMISSIONING OF ELECTRICAL EQUIPMENT					
	The Contractor to Decommision all Transformers a, cables, MV Equipment and Buy as Scrap material					
8.1.1	Building 3, 250kVA 11kV/400V Transformers with Associated LV Equipment	each	3			
8.1.2	Building 3, 11kV Breakers with Associated MV Equipment including Busbars and Cables	each	3			
8.1.3	Building 33, 250kVA 11kV/400V Transformers with Associated LV Equipment	each	2			
8.1.4	Building 33, 11kV Breakers with Associated MV Equipment including Busbars	Sum	2			
8.2	REDUNDANT EQUIPMENT					
	Offer Price for Redundant Equipment	Sum	1			



CSIR TRAI	NSFORMER REPLACEMENT	Sub Total
BILL 01	P&G	
BILL 02	Cables and Ground Works-Building 3	
BILL 03	Cables and Ground Works-Building 33	
BILL 04	Sleeves	
BILL 05	Earthing and Lightning Protection	
BILL 06	Bulk Electrical Equipment	
BILL 07	Chromadeck shelter	
BILL 08	Decommissioning	
SUB TOTAL		
10% Conting	gency	
SUB TOTAL		
15% Vat		
TOTAL		