

	Technical Specification	Technology
---	--------------------------------	-------------------

Title: **Outside plant MV switchgear Replacement Project Technical Specification Report**
 Unique Identifier: **ECME 0049**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**

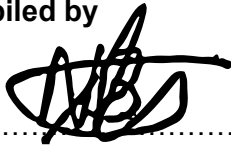
Documentation Type: **Technical Specification**

Revision: **1**

Total Pages: **60**

Next Review Date: **N/A**

Disclosure Classification: **CONTROLLED DISCLOSURE**

Compiled by  NB Mdletshe System engineer Electrical engineering Date: ..03/08/2021.....	Functional Responsibility  DS Zitha Senior engineer Electrical engineering Date: ...03/08/2021.....	Authorised by  GNM Brink Manager: Electrical engineering Date: 2021/08/03.....
---	---	--

CONTENTS

	Page
1. INTRODUCTION	5
2. SUPPORTING CLAUSES	5
2.1 SCOPE	5
2.1.1 Purpose	5
2.1.2 Applicability.....	5
2.2 NORMATIVE / INFORMATIVE REFERENCES.....	6
2.2.1 Normative	6
2.2.2 Informative.....	7
2.3 DEFINITIONS.....	7
2.3.1 Classification	7
2.3.2 Malfunction	7
2.3.3 System.....	7
2.4 ABBREVIATIONS.....	7
2.5 ROLES AND RESPONSIBILITIES.....	9
2.6 PROCESS FOR MONITORING	10
2.7 RELATED / SUPPORTING DOCUMENTS.....	10
3. DESCRIPTION OF THE WORKS	11
3.1 SCOPE OF WORKS	11
3.2 EMPLOYER'S OBJECTIVES.....	11
3.3 BATTERY LIMITS	12
4. SYSTEM DESCRIPTION	12
5. DESIGN INFORMATION.....	13
5.1 EMPLOYER'S DESIGN.....	13
5.1.1 Existing Plant.....	13
5.1.2 Employer's Design Information	13
5.2 CONTRACTOR'S DESIGN	14
5.2.1 Electrical System Design.....	14
5.2.2 Cabling	14
5.2.3 Structural System Design.....	14
5.2.4 Control and Instrumentation System Design.....	15
6. TECHNICAL REQUIREMENTS.....	15
6.1 GENERAL.....	15
6.2 ELECTRICAL RETICULATION.....	16
6.3 EQUIPMENT RATINGS AND CONFIGURATIONS.....	17
6.4 SWITCHGEAR LOCATION.....	19
6.5 CABLING, ROUTING AND RACKING	20
6.5.1 Cable Routing.....	20
6.5.2 Cable Replacement [Cable Schedule Attached]	21
6.5.3 Cables to be Tested	28
6.5.4 Disconnecting Of Existing Cables	29
6.5.5 Reconnecting And Termination Of Cables.....	29
6.5.6 Drilling Of Holes For Cabling Requirements	29
6.5.7 Site/ Ground preparation	30
6.5.8 Excavation	30
6.5.9 Repair / Replacement Of Damage To Existing Plant And Material.....	30
6.5.10 Cable crossing other services	30
6.5.11 Road and two tier fence crossings	31
6.5.12 Bedding and backfilling	32
6.5.13 Pulling of Power Cable	32

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

6.5.13.1 Cable pull cards	32
6.5.13.2 Direction of drum rotation	33
6.5.13.3 Intermediate storing of cables at site	33
6.5.14 Labelling	33
6.5.15 Medium voltage power cables	34
6.5.15.1 Voltage rating	34
6.5.15.2 Terminations	34
6.5.16 Low voltage power cables	34
6.5.16.1 Low Voltage Power cable terminations	34
6.5.17 Cable racks	35
6.5.18 Cable route markers	35
6.5.19 Cable Joints and Terminations	36
6.5.20 Termination through gland plates	36
6.5.21 Termination of cables in switchboards	36
6.5.22 Earthing of equipment and cables	37
6.5.23 Cable lugs and crimping tools	37
6.5.24 Torquing of Connections	37
6.5.25 Sealing Of Holes In Floors And Walls	38
6.5.25.1 Sealing of switchgear Cable entries	38
6.5.25.2 Temporary Fire Barriers	38
6.5.25.3 Permanent Fire Barriers	38
6.5.26 Closing of cable entries to buildings and transformer bays	38
6.5.27 Closing of Unoccupied Cable Slots in Switchgear Rooms	39
6.5.28 TESTING AND COMMISSIONING OF CABLES	39
6.5.28.1 Type Testing	39
6.5.28.2 Insulation Resistance	39
6.5.28.3 High voltage tests	40
6.5.29 Commissioning	40
6.6 LIGHTING AND SMALL POWER INSTALLATIONS	40
6.7 EARTHING AND LIGHTNING PROTECTION	40
6.8 CONTROL AND INSTRUMENTATION	40
6.9 LOW PRESSURE SERVICES	42
6.9.1.1 Conveyor board 1&2 ventilation requirements	43
6.9.1.2 Station boards ventilation requirements	43
6.10 CIVIL AND STRUCTURAL	44
6.11 DECOMMISSIONING AND CONSTRUCTION	46
6.11.1 Decommissioning	46
6.11.2 Construction and erection phase	46
6.11.3 Temporary works, Site services & construction constraints	46
7. INFORMATION REQUIREMENTS	47
7.2 GENERAL	47
7.3 SYSTEM DESCRIPTIONS AND PHILOSOPHIES	47
7.4 DOCUMENTATION AND CONFIGURATION MANAGEMENT	47
7.4.1 Document Management	47
7.4.1.1 Document Submission	47
7.4.2 DRAWINGS FORMAT AND LAYOUT	47
7.4.3 PLANT CODING AND LABELLING	48
7.5 DESIGN REVIEW OF ELECTRICAL SYSTEMS	48
7.5.1 Design Review Procedure	49
7.5.2 Engineering Change Procedure	49
8. STORAGE AND PRESERVATION	49
8.1 TRANSPORTATION, DISPOSAL AND INSTALLATION	49
8.1.1 Equipment Rigging	50
9. AUTHORISATION	50

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

10. REVISIONS	50
11. DEVELOPMENT TEAM	50
12. ACKNOWLEDGEMENTS	51
APPENDIX A: SINGLE LINE DIAGRAMS	52
APPENDIX B: EQUIPMENT LIST TECHNICAL PARAMETERS	53
APPENDIX C: SWITCHGEAR SCHEDULES.....	54
APPENDIX D: MV SWITCHGEAR SCHEDULE A&B.....	55
APPENDIX E: PROTECTION SCHEME TECHNICAL SCHEDULE A&B	56
APPENDIX F: CONTROL AND INSTRUMENTATION SIGNALS	57
APPENDIX G: PROTECTION & CONTROL FUNCTIONAL INTERFACE	58
APPENDIX H: DC EQUIPMENT LIST	59
APPENDIX I: SUBSTATION LAYOUTS	60
APPENDIX J: VDDS & LOSS	61

FIGURES

Figure 1: 11kV Cable Route Indication from Station Board 1 to ASQ Board 1	22
Figure 2: 11kV Cable Route Indication from Station Board 2 to Security Mini-Sub	23
Figure 3: 11kV Cable Route Indication from Security Mini-Sub to ASQ Board 2.....	23
Figure 4: 11kV Cable Route Indication from ASQ Board 1 & Board 2 to Sewage Plant Board	24
Figure 5: 11kV Distribution Transformer 1 showing HV cable.....	24
Figure 6: 11kV Distribution Transformer 2 showing LV cables, HV Cable is on the other side	25
Figure 7: 11kV Standby-Set 3 & 4 HV Cable	25
Figure 8: HV Cables on Left Hand Side for 11kV Distribution Transformer 1 and 2 on Cable Racks	26
Figure 9: HV Cable of 11kV Standby-Set 3 & 4 Transformer on Right-Hand Side	27
Figure 10 : Power cable running parallel to telecommunication cable	31
Figure 11: Power cable crossing other services.....	31
Figure 12: Arrangement of cable drum	33
Figure 13: MicroSCADA configuration.....	41

TABLES

Table 1: List of Appendices	15
Table 2: 11 kV Switchgear to be replaced	17
Table 3: IED protectionrelays per board	18
Table 4: DC equipment to be supplied	19
Table 5:11kV Cables to be replaced by Contractor	21
Table 6:Cables to be tested by Contractor	28
Table 8. Summary of room dimensions and existing ventilation.	43
Table 9. Station board ventilation basic design assumptions.....	43
Table 10. Summary of basic design ventilation requirements.....	44
Table 11: Drawing paper sizes	48

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

1. INTRODUCTION

Arnot power station has outside plant MV switchgear which has exceeded its end of life and no longer supported by the OEM. The switchgear also poses high safety risk due to unreliable protection. There have been explosions in the past years leading to equipment damages, making it unsafe to work on these boards. The switchgear is not internal arc compliant, nor does it have arc protection, which means that arcing in the switchgear will not be contained to a single compartment, it will propagate to adjacent compartments. Not only is the switchgear unsafe, but it is also difficult to maintain due to obsolescence and lack of technical skills.

The outside plant MV switchgear supplies power to the common plant auxiliaries. Common plant refers to the coal plant, water treatment plant, and ash plant. Station boards 1 and 2 are the main source of supply for the outside plant. Station boards 1 and 2 are supplied by station transformers 1 and 2, respectively, located at the HV yard. Protection relays for the MV switchgear are powered by DC power, which is sourced from battery chargers. Arnot power station electrical reticulation is illustrated in drawing--0.41/304.

The project aims to do a replacement of the installed selected outside plant MV switchgear, which is contained and detailed in this technical specification for improved plant safety, reliability and maintainability. These should be replaced with new switchgear complying with the current Eskom specifications as contained in section 2.2. The project limits are captured and documented in the Limits of Supply and Services (LOSS), detailed in Appendix B of this document. At different phases of this project, design and hand over documents will have to exchange from and to the *Employer* and vice versa to the *Contractor* and is managed through a Vendor Document Submittal Schedule (VDSS), as detailed in Appendix C of this specification.

2. SUPPORTING CLAUSES

2.1 SCOPE

The scope of this document is limited to the Arnot outside plant MV switchgear replacement project, which includes installation of new MV switchgear with their associated battery chargers and control cabling, structures, HVAC and control and instrumentation *Works*, and all the other associated *Works* directly and indirectly interfaced with the *Works*.

2.1.1 Purpose

This document summarises the engineering requirement, documentation requirement, , manufacturing requirement, quality control and assurance, supply, installation, training, testing, commissioning and handover of the new MV switchgear *Works*.

2.1.2 Applicability

The document applies to all Arnot Power Station affected personnel and to all affected engineering disciplines including asset management.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

- [1] 240-56227443: Requirements for Power and Control Cables for Power Stations
- [2] 240-143485806: Generation auxiliary plant medium voltage protection standard
- [3] 240-56357424: MV And LV Switchgear Protection Standard
- [4] 240-53113685: Design Review Procedure
- [5] 240-53114026: Project Engineering Change Procedure
- [6] 240-53459028: Perform Power Plant Electrical Engineering
- [7] 240-52844004: Medium and Low Voltage Switchgear Design Guideline
- [8] 240-56356396: Earthing and Lightning Protection Standard
- [9] 240-56227573: Air-Insulated Withdrawable AC Metal-Enclosed Switchgear and Control Gear for Rated Voltages above 1kV up to and including 52kV
- [10] 240-70164623: Design Guideline for HVAC in the Eskom Coal Fired Power Stations
- [11] 474-11685: Medium and Low Voltage switchgear design scope of work
- [12] 240-76366372: specification for a platform mounted ring main unit switchboard for systems with nominal voltage of 11 kV up to 22 kV
- [13] SANS 1874:2015: Switchgear — Metal-enclosed ring main units for rated a.c. voltages above 1 kV and up to and including 36 kV
- [14] 240-56030406: Specification for ring main units for systems with nominal voltages from 3.3kV to 33 kV
- [15] SANS 62271: High-voltage switchgear and controlgear
- [16] 240-56241933 - Control of Plant Construction Repair and Maintenance Welding Activities Standard
- [17] 240-56246601 - Personnel and Entities Performing Welding Related Special Processes on Eskom Plant Standard
- [18] 240-56247004 - Thermal Insulation Standard
- [19] 240-83539994 - Eskom NDT Personnel Approval (NPA) for Quality Related Special Processes on Eskom Plant Standard.
- [20] 240-83540088 - Requirements for Non-Destructive Testing (NDT) on Eskom Plant Standard.
- [21] SANS 10131 - Above-ground storage tanks for petroleum products.
- [22] SANS 10252-1 - Water supply and drainage for buildings Part 1: Water supply installations for buildings.
- [23] SANS 10252-2 - Water supply and drainage for buildings Part 2: Drainage installations for buildings.
- [24] SANS 347 - Categorization and conformity assessment criteria for all pressure component.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.2.2 Informative

- [25] Arnot power station outside plant MV switchgear replacement project User Requirement Specification (URS)
- [26] Arnot power station – Load Flow and Fault Study
- [27] 384-PRJ-1-DDDD-D00185-3: Arnot Power Station Outside Plant MV Switchgear Replacement Project Basic Design

2.3 DEFINITIONS

2.3.1 Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.3.2 Malfunction

The termination of the ability of an equipment to carry out intended functions or the execution of unintended functions by the equipment.

2.3.3 System

An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, hardware, software, firmware, information, procedures, facilities, services and other support facets.

2.4 ABBREVIATIONS

Abbreviations	Description
A	Ampere
AC	Alternating Current
ACB	Air Circuit Breaker
AFLR	Authorised Front Lateral and Rear
AIS	Air Insulated Switchgear
ASQ	Arnot Single Quarters
BFP	Boiler Feed Pump
BOP	Balance of Plant
C&I	Control and Instrumentation

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Abbreviations	Description
CRA	Concept Release Approval
C&I	Control & Instrumentation
CT	Current Transformer
DC	Direct Current
DCS	Distributed Control System
DEP	Design Engineering Practitioner
EDWL	Engineering Design Work Lead
EMD	Electrical Maintenance Department
EMDAS	Energy Measurement and Data Acquisition System
EOD	Electrical Operating Desk
FD	Forced Draught
GIS	Gas Insulated Switchgear
GTE	Group Technology Engineering
HV	High Voltage
HVAC	Heating, Ventilating and Air Conditioning
I/O	Input Output
IEC	International and Electrotechnical Commission
ID	Induced Draught
IED	Intelligent Electronic Device
LDE	Lead Discipline Engineer
LPS	Low Pressure Services
LV	Low Voltage
MV	Medium Voltage
N/A	Not Applicable

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Abbreviations	Description
PDD	Project Development Department
PLC	Programmable Logic Controller
PS	Power Station
PTM	Protection, Telecommunication & Metering
ROC	Requirement Operational Capability
SAS	Substation Automation System
SF ₆	Sulphur Hexafluoride
UCLF	Unplanned Capability Factor
URS	User Requirement Specification
V	Voltage
XLPE	Cross-linked Polyethylene

2.5 ROLES AND RESPONSIBILITIES

Compiler: The document compiler is responsible for ensuring that this document is up-to-date and that this document is not a duplication of an existing documentation, regarding the document's objectives and content.

Functional Responsibility: The Functional Responsible Person shall determine if the document is fit for purpose, before the document is submitted for authorisation.

Authoriser: The document authoriser is a duly delegated person with the responsibility to review the document for alignment to business strategy, policy, objectives and requirements. He/she shall authorise the release and application of the document.

Lead Discipline Engineer: The role of the Lead Discipline Engineer is to manage the technical integrity of the design and be accountable for the management of the interfaces within their specific engineering domain. In addition, the Lead Discipline Engineer coordinate the discipline specific activities for the particular package/plant/system/asset such as Protection, Telecommunications, Control, Metering, Turbine, Boiler, Bulk Materials Handling (BMH), Civil, Electrical, Control and Instrumentation (C&I), Chemical, Low Pressure Services (LPS), etc. In addition, the Lead Engineer is accountable for the provision and establishment of all documentation required for a Design Review. The Lead Discipline Engineer is to ensure that a system of check sheets is being used in the review process and before the design review package is put together for the end of phase design review meeting he reviews and signs off on these documents.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Furthermore, design review procedure 240-53113685 defines roles and responsibilities which are applicable in the development of this design phase.

2.6 PROCESS FOR MONITORING

This document will be approved following a Technical Specification Review that will be performed as per the Design Review Procedure 240-53113685.

2.7 RELATED / SUPPORTING DOCUMENTS

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

3. DESCRIPTION OF THE WORKS

3.1 SCOPE OF WORKS

The scope for the project includes decommissioning, removal of the installed MV switchgear, decommissioning, removal of the installed battery chargers and batteries, decommissioning and removal of associated power/control cables, decommissioning and removal of existing extraction fans, all removed equipment will be moved to a dedicated areas, as per the site requirements. Design, manufacturing, FAT, supply, deliver to site, off load, move to position, install, SAT, commissioning and handover to site of the new MV switchgear to be installed on the outside plant MV switchgear rooms at Arnot Power Station. Power and control cabling is required for the new chargers and new MV switchgear to be installed. Furthermore, design, testing, installation, commissioning and handover of support structures as detailed in Section 6.11 is required.

The systems covered by the project are MV switchgear installed in outside plant 11 kV switchgear rooms, battery charger unit, MV switchgear protection, power cables, lighting, alarms, air extraction system, and support structure. The summary of the *Works* includes, but not limited to the following:

- The *Contractor* decommissions and removes the existing MV switchgear, battery chargers, extraction fans and cabling as per the scope detailed herein.
- The *Contractor* replaces the existing switchgear and battery chargers as per the scope detailed herein with new switchgear and battery chargers and batteries.
- The *Contractor* replaces the existing extraction fans in coal conveyor board 1&2.
- The *Contractor* provides support structures as detailed in Section 6.10 of this specification, for the switchgear exhausting arc duct in station board 1 and 2.
- The *Contractor* installs new control cables between all MV switchgear and the respective local alarm interfaces.
- The *Contractor* ensures that all interfaces are designed and executed accordingly.
- The *Contractor* reposition the existing lights in the substation such that there is adequate illumination in the substation if the new switchgear obstructs the existing lights. The *Contractor* shall discuss with the *Employer* prior to the repositioning of the existing lights.

3.2 EMPLOYER'S OBJECTIVES

The main objective is to provide the technical specifications detailing MV switchgear replacement scope of work as well as scope of all supporting systems. The following minimum requirements shall be met.

a) Replacement of the existing MV switchgear with new switchgear design of the latest technology and comply with Eskom switchgear standard (240-56227573, 240-76366372, and 240-56030406) listed in section 2.2

b) The new switchgear shall be fitted with protection schemes of the latest technology and with functionalities as specified in the Eskom generation protection standard 240-143485806.

c) Testing and replacement of power cables shall be as per Eskom standard (240-56227443) for power cables.

e) The latest intelligent electronic devices (IED's) protection equipment with designed life of a minimum of 15 years.

f) Heating, ventilation and air conditioning (HVAC) in all the Switchgear rooms addressed by the project.

g) Maintain the Control & Instrumentation (C&I) interface on the MV&LV Switchgear.

h) Improve remote monitoring of the switchgear for coal conveyor board 1&2

- The system shall be easily maintainable and inspectable.
- The design is to further ensure that the station reticulation design base is retained.
- The equipment shall occupy the identified footprint due to space constraints in the substations.
- The system shall interface to the cascading LV boards, outside plant SCADA, and station control room (EOD).
- The expansion of the Outside Plant SCADA is excluded from the works, however the terminations and commissioning to the expansion modules are included.

3.3 BATTERY LIMITS

The *Contractor's* scope for this project is limited to the following:

- The 11 kV supply from station transformer 1&2 to station board 1&2
- The 11 kV supply to all the outside plant 11kV MV boards listed in the equipment schedule
- Feeders to all cascading loads of each outside plant MV boards listed in the equipment schedule
- Control power cables from different DC power supplies
- LV AC supply to extraction fans
- Connections to and from all current transformers and voltage transformers of each outside plant MV boards
- Decommissioning and removal of the existing outside plant MV boards with associated components
- Decommissioning and removal of existing I/O cables from existing switchgear to the DCS
- Connecting new I/O cables to the DC
- Supply new MV switchgear with IED relays and/ self powered relays as per the equipment schedule specification
- Provision of support structures to be used for the new equipment as required
- Install & terminate I/O cables to interface the coal conveyor boards 1&2 alarms to the outside plant SCADA system

4. SYSTEM DESCRIPTION

The primary distribution switchgear shall be designed and manufactured as per the 240-56227573: Air-Insulated Withdrawable AC Metal-Enclosed Switchgear and Control Gear for Rated Voltages above 1kV up to and including 52kV. The secondary switchgear shall be designed as per the Eskom standard 240-76366372. The existing outside plant reticulation shall be maintained as is, the reticulation is depicted on the drawing medium and low voltage electrical boards station diagram-0.41/304. The protection relays

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

on all MV switchgear shall be designed and manufactured as per the 240-143485806: Generation auxiliary plant medium voltage protection standard. The primary distribution switchgear protection shall be equipped with IED relays and secondary distribution switchgear shall be equipped with self powered relays with protection functions as listed in the equipment list schedule.

5. DESIGN INFORMATION

5.1 EMPLOYER'S DESIGN

5.1.1 Existing Plant

The existing plant data is provided by the *Employer*. Where additional information is required, the *Contractor* collects all data for the design, including process and existing plant data and information from the *Employer*, to enable the completion of the works. The existing switchgear is located at different locations in the power station. The station board 1&2 are located inside the main building at 45 ft level in different rooms. Coal conveyor boards are located outside the plant in the coal plant area. ASQ 1&2 are located outside the station in the Arnot single quarters area. Sewage plant board is located outside the station in the Sewage plant. The new switchgear will be located in the same locations as the existing switchgear. The DC supply to the control equipment and cables is located at different locations; DC supply to station board 1&2 is from the SOB board located at the 1st floor in the main building. DC supply to the coal conveyor boards 1-13 is from the DC chargers inside the coal conveyor board 1&2 substation. DC supply to ASQ board 1&2 and sewage plant board is from the DC chargers located inside the sewage plant board substation.

The two CW north and south reserves shall be equipped with differential protection scheme thus modifications on the CW motor transformer terminals shall be performed, to be sufficiently big enough to accommodate three new CTs (class X). The existing CW motors are 2386.2 kW 3.3 kV three phase motor coupled to a 4 MVA transformer.

The communication from Station Boards 1&2 currently run to the Micro Scada situated in the IDF below the SOR. The existing communication system is an ABB SCADA system. System intergator generates a Switchgear Protection Face plate on the SCADA and set up the alarms, historical trending and reporting logs. System intergator generates Mimic pages on the SOR screens.

The coal conveyor boards 1&2 are equipped with two pressurizing fans of 0.75 kW three phase supply.

5.1.2 Employer's Design Information

The *Employer* has completed some preliminary designs. Information from the *Employer's* design are made available throughout this *Specification*. All drawings from the *Employer's* design for the works are provided as input for the *Contractor* to validate and update the designs for detail design purposes.

The *Employer* will, as a minimum, provide the following documentation/drawings and detail submission shall be listed and agreed upon as listed in Appendix J:

- a) Technical Switchgear schedules
- b) Substation layouts
- c) Single line diagrams for switchgear.

See LOSS diagrams in Appendix J and VDSS in Appendix J for details and scope split.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

5.2 CONTRACTOR'S DESIGN

The *Contractor* develops the *Employer's* design into a detailed design for all *Works*. The *Contractor* standardises the designs and installations across all affected areas.

5.2.1 Electrical System Design

The scope of work includes detail design, manufacture and/or procure, Factory Acceptance Test, supply, delivery, off-loading, more to position, installation, site acceptance testing (SAT), training, commissioning and handover the *Works*, with respect to the MV switchgear, DC chargers & batteries, and pressurizing fans for Arnot Power Station. The scope also includes the following:

- a) The *Contractor* shall be responsible for decommissioning and removal of the existing MV switchgear with associated cabling out of the substations/ switchgear rooms to the area identified by the *Employer*.
- b) The *Contractor* shall be responsible for decommissioning and removal of the existing DC chargers in the coal conveyor boards 1&2 and sewage plant board with associated cabling out of the substations/ switchgear rooms to the area identified by the *Employer*.
- c) The *Contractor* shall be responsible for decommissioning and removal of the existing pressurizing fans in the coal conveyor boards 1&2 with associated cabling out of the substations/ switchgear rooms to the area identified by the *Employer*.
- d) The *Contractor's* design shall interface with the existing 11 kV supply from station transformer 1&2 and station board 1&2. The *Contractor's* design shall also interface with existing cascading switchgear/load on each feeder
- e) The *Contractor's* design for station board 1&2 shall interface with control supply cables from the 220 V DC SOB board.
- f) The *Contractor* performs all necessary bonding and testing of all installed equipment.
- g) The *Contractor* shall perform modifications on the CW north and south reserves motor transformer terminals for compatibility with differential protection
- h) The *Contractor* replaces all lamps in the substations with LEDs ; this shall be accepted the *Employer*.

5.2.2 Cabling

The *Contractor* shall supply, delivery, off-loading, storage on site, installation, terminating, testing and commissioning of new MV and LV cables (including the MV and LV cables needed for extending existing cables), cable accessories (i.e. cable glands, lugs, termination systems, jointing systems etc.), and earthing materials.

5.2.3 Structural System Design

- a) The *Contractor* designs the supporting structures for the switchgear, battery chargers, and batteries such that no structural integrity is compromised.

CONTROLLED DISCLOSURE

- b) Any damages to the structure resulting from installation of the new switchgear and associated interfaces shall be fixed by the *Contractor*. any construction work shall be according to the Eskom standard 240-56364545
- c) The same positioning of the switchgear shall be retained as much as possible, if for any valid reason discussed with the *Employer* the switchgear cannot be placed on the same position as the existing position, then the *Contractor* shall cover all the previous cable entry holes on the floor resulting from the movement of the switchgear according to 240-56364545.
- d) Any mounting of the switchgear shall be done by the *Contractor*.

5.2.4 Control and Instrumentation System Design

- a) The *Contractor* designs, manufactures, FAT, supplies, installs, SAT, commissions and handover of switchgear monitoring & control interfaces.
- b) The *Contractor* designs and interfaces the switchgear alarms to the Historian to ensure that the alarm signals are archived correctly.
- c) All alarm configuration, connections, and any alarm related works shall be according to

6. TECHNICAL REQUIREMENTS

The scope should be read in conjunction with the following Appendices:

Table 1: List of Appendices

Appendix	Title
A	Single Line Drawings
B	Equipment list technical parameters
C	Switchgear schedules
D	MV technical schedule A&B
E	Protection scheme technical schedule A&B
F	Control and Instrumentation signals and functional interface diagram
G	DC equipment list
H	Substation layouts
I	VDSS and LOSS

6.1 GENERAL

- a) The design of the plant shall ensure standardization for simplified operation and maintenance, optimised spares holdings and reduced lifecycle management costs.
- b) The *Contractor* shall ensure that the design considers the space constraints in the substation
- c) The *Contractor* shall, in the execution of the *Works*, accordingly employ a uniform approach across the *Works* with respect to design philosophy, basic functional characteristics, system interfaces, documentation and engineering tools. The *Contractor* shall maximise the level of compatibility, inter-

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

changeability and commonality in the operational, procedural, material, technical and administrative fields to achieve interoperability.

- d) In the event of a conflict between requirements, the *Employer* decides which shall apply. The *Contractor* clearly states in writing any deviation from these. Absence of such statements is interpreted to mean that the offer is in compliance with these requirements.
- e) All components and materials of manufacturing are new.
- f) The *Works* shall function as required under the ambient and other environmental conditions prevailing at the plant without any detrimental influence on the normal life expectancy.
- g) The *Contractor* clearly identifies the Plant and/or parts thereof that require maintenance at regular intervals. The intervals shall be determined and the details of the maintenance actions shall be documented. The *Contractor* reflects this in the maintenance plan and the associated detailed work instruction.
- h) To minimise outage times, the *Contractor* utilises readily replaceable components and provide adequate test instructions to enable maintenance personnel to quickly locate and replace faulty components. Replacement shall be possible from spare parts supplied from the manufacturer without mechanical or electrical modifications of the system.
- i) General safety design and installation requirements will be as follows:
 - I. Do not mount electrical equipment on removable walkways or structures.
 - II. Shroud or shield live parts of electrical equipment mounted in enclosures to prevent unintentional contact by personnel.
 - III. Lockable enclosures shall have provision for securing by means of padlocks and/or panel keys.
- j) The primary distribution switchgear shall be designed and manufactured as per the 240-56227573: Air-Insulated Withdrawable AC Metal-Enclosed Switchgear and Control Gear for Rated Voltages above 1kV up to and including 52kV.
- k) The secondary switchgear shall be designed as per the Eskom standard 240-56030406.
- l) The protection relays on all MV switchgear shall be designed and manufactured as per the 240-143485806: Generation auxiliary plant medium voltage protection standard.

6.2 ELECTRICAL RETICULATION

The *Contractor* is responsible for the following as a minimum:

- a) Retain the electrical reticulation baseline by observing the interfacing systems such as cabling that interface with the 11 kV supplies and protection & control .
- b) The major components that form part of the system include:
 - MV switchgear panels
 - Power cables
 - Protection relays
 - Battery chargers and batteries with associated battery cabinets
- c) Perform design calculations and verify sizing of electrical equipment and plant thus ensuring adequate protection grading
- d) Develop or update the following drawings to "As Built":

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- cable block diagrams
- cable schedules
- termination schedules
- substation layouts
- general arrangements
- schematic diagrams
- single line diagrams.
- Heat loads of IEDs

e) Update electrical plant operating philosophy.

6.3 EQUIPMENT RATINGS AND CONFIGURATIONS

The *Contractor* designs, manufactures, FATs, stores (where required), supplies, delivers, installs, SATs, commissions, trains, handover of the following *Works*.

- a) Two 25 A 110 V battery chargers with NiCad batteries rated at 38 Ah and a 110 V 10 A battery charger with 20 AH NiCad batteries over a one hour autonomy. Chargers shall be designed such that the input supply is a 3+N.
- b) Two air filled terminal boxes equipped with differential protection terminations for 3.3 kV 2386.2 kW induction motors coupled to a 11 kV/ 3.3 kV 4 MVA power transformers each. The terminal box shall have clearances as per the SANS 876 standard.
- c) The new MV switchgear shall have the following ratings and shall be of the listed switchgear types in table 2 below.

Table 2: 11 kV Switchgear to be replaced

Item	Board description	Number of panels	Type	Short cct rating (kA)
1	11 kV Station board 1	16	AIS	25
2	11 kV Station board 2	18	AIS	25
3	Coal conveyor board 1	5	AIS	25
4	Coal conveyor board 2	6	AIS	25
5	Coal conveyor board 3	3	AIS RMU	20
6	Coal conveyor board 4	3	AIS RMU	20
7	Coal conveyor board 5	3	AIS RMU	20
8	Coal conveyor board 6	3	AIS RMU	20
9	Coal conveyor board 7	3	AIS RMU	20

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

10	Coal conveyor board 8	3	AIS RMU	20
11	Coal conveyor board 9	3	AIS RMU	20
12	Coal conveyor board 10	3	AIS RMU	20
13	Coal conveyor board 11	3	AIS RMU	20
14	Coal conveyor board 12	3	AIS RMU	20
15	Coal conveyor board 13	3	AIS RMU	20
16	Arnot Single Quarters board1	3	GIS RMU	20
17	Arnot Single Quarters board 2	3	GIS RMU	20
18	Sewage board	3	GIS RMU	20

- d) The switchgear protection devices shall be fitted with the following protection schemes. The protection schemes shall be the latest available technology in the market.
- e) The protection devices shall be in the list of the Eskom list of approved electronic devices

Table 3: IED protectionrelays per board

MV Switchgear	Protection Schemes	Power Consumption per Scheme (W)	Number of schemes per board
Station Board 1	*PA1600	<50	1
	*PA1700	<50	1
	*PA1200	<50	2
	*PA1000	<50	9
	*PA0200	<50	1
Station Board 2	*PA1600	<50	1
	*PA1700	<50	1
	*PA1200	<50	2
	*PA1000	<50	9
	*PA0200	<50	1
Coal conveyor board 1	*PA1600	<50	1
	*PA1700	<50	1
	*PA1200	<50	2
	*PA0800	<50	2

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

	*PA1000	<50	2
Coal conveyor board 2	*PA1600	<50	1
	*PA1700	<50	1
	*PA1200	<50	2
	*PA0800	<50	2
	*PA1000	<50	3

- f) Station boards 1 and 2 shall be equipped with an arc duct for exhausting arc gases to the atmosphere.
- g) All RMUs shall come standard with self powered relays equipped with Overcurrent and Earth Fault Protection.

Table 4: DC equipment to be supplied

Item	Board description	Charger size	Battery technology	Battery size
1	11 kV conveyor board 1	25 A 110 Vdc	NiCd	38 AH
2	11 kV conveyor board 2	25 A 110 Vdc	NiCd	38 AH
3	Sewage plant board	10 A 110 Vdc	NiCd	11 AH

6.4 SWITCHGEAR LOCATION

- a) All boards shall be installed in the existing substations or switchgear rooms
- b) Station board 1 shall be installed in the existing station board 1 & 3 switchgear room; Station board 2 shall be installed in the existing station board 2 & 4 switchgear room; the existing switchgear panel arrangement is 19.41/21797
- c) Coal conveyor board 1&2 shall be installed in the existing coal conveyor board 1&2 substation
- d) Coal conveyor board 3&6 shall be installed in the existing coal conveyor board 3&6 substation; the existing substation layout is 41/39996 sheet 4
- e) Coal conveyor board 5&4 shall be installed in the existing coal conveyor board 4&5 substation; the existing substation layout is 41/39996 sheet 3
- f) Coal conveyor board 7&12 shall be installed in the existing coal conveyor board 7&12 substation; the existing substation layout is 41/39996 sheet 5

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- g) Coal conveyor board 8&11 shall be installed in the existing coal conveyor board 11&8 substaion
- h) Coal conveyor board 9&10 shall be installed in the existing coal conveyor board 10&9 substaion; the existing substation layout is 41/39996 sheet 7
- i) Coal conveyor board 13 shall be installed in the existing coal conveyor board 13 substaion; the existing substation layout is 41/39996 sheet 8
- j) ASQ board 1&2 shall be installed in the existing ASQ board 1&2 substation; the existing substation layout is 0.41/39996 sheet 10
- k) Sewage plant shall be installed in the exsting sewage plant board substation ; the existing substation ayout is 0.41/39996 sheet 9

6.5 CABLING, ROUTING AND RACKING

**Cabling shall comply Eskom standard (240-56227443) for power cables.*

The supply, delivery, off-loading, storage on site, installation, terminating, testing and commissioning of new MV and LV cables (including the MV and LV cables needed for extending existing cables), cable accessories (i.e. cable glands, lugs, termination systems, jointing systems etc.), and earthing materials.

The *Contractor* shall ensure that care is taken at all times when cables are to be moved so as to not cause further disturbances as many of the existing cables are PILC and are fragile

The *Contractor* is required to:

- Do excavation of the route
- Supply the required cable
- Prepare the ground as per the scope of work
- Insert sleeves underneath the road where specified or required
- Install the cable in the ground and cable supports were applicable
- Join the cables where required
- Perform the relevant electrical tests of the cables and provide results
- Backfill the cable route
- Provide QCPs for approval

**All length must be verified by the Contractor before quotations. Length will be finalised and agreed before contract award.*

6.5.1 Cable Routing

- a) The *Contractor* shall use the existing route for cables that need to be replaced (the existing route is not readily available but an indication of the route is shown in Figures 1 - 4). In the event no indication/route is provided, the *Contractor* will first need to locate the cable route before any replacement can commence .
- b) After site clearance, the *Contractor* shall detect and mark the old cable. The contractor must arrange this activity during Arnot's normal working hours and ensure that Eskom's allocated Electrical Engineer witnesses this.

CONTROLLED DISCLOSURE

c) An indication for the cable routing [Figure 1 – 4]:

- 11kV Station Board 1 to 11kV ASQ Board 1
- - 11kV Station Board 2 to 11kV Security Mini – Sub
- - 11kV Security Mini-Sub to 11kV ASQ Board 2
- - 11kV ASQ Board 2 to 11kV Sewage Board
- - 11kV ASQ Board 1 to 11kV Sewage Board

d) The Cable route for the below, is under the bund wall then onto cable racks, through the foundation and it goes to 45ft level to the Station Boards [Figure 5 – 7]

- 11kV Station Board 1 to 11kV Standby-Set 1 & 2
- 11kV Station Board 2 to 11kV Standby-Set 3 & 4
- 11kV Station Board 1 to 11kV Distribution Transformer 1
- 11kV Station Board 1 to 11kV Distribution Transformer 2

e) The cable route for the conveyors 3 – 13 can be found next to each coal conveyor board substation building.

6.5.2 Cable Replacement [Cable Schedule Attached]

Power Cables to be REPLACED by the Contractor:

Table 5:11kV Cables to be replaced by Contractor

Cables to be replaced	Length(m)	New Cable to use
Cable from from 11kV Station Board 1 to 11kV ASQ Board 1	1500	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Station Board 2 to 11kV Security Mini-Sub	1000	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Security Mini-Sub to 11kV ASQ Board 2	1000	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV ASQ Board 2 to 11kV Sewage Board	1000	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV ASQ Board 1 to 11kV Sewage Board	1000	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Station Board 1 to 11kV Standby-Set 1 & 2 Transformer	200	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Station Board 2 to 11kV Standby-Set 3 & 4 Transformer	100	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Station Board 1 to 11kV Distribution Transformer 1	100	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Station Board 1 to 11kV Distribution Transformer 2	100	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 6 to 11kV Conveyor 6 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 5 to 11kV Conveyor 5 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 4 to 11kV Conveyor 4	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Transformer		XLPE
Cable from 11kV Conveyor Board 3 to 11kV Conveyor 3 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 13 to 11kV Conveyor 13 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 12 to 11kV Conveyor 12 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 11 to 11kV Conveyor 11 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 10 to 11kV Conveyor 10 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 9 to 11kV Conveyor 9 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 8 to 11kV Conveyor 8 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE
Cable from 11kV Conveyor Board 7 to 11kV Conveyor 7 Transformer	5	11kV, Copper, 185mm ² , SWA, 3-core, XLPE



Figure 1: 11kV Cable Route Indication from Station Board 1 to ASQ Board 1

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



Figure 2: 11kV Cable Route Indication from Station Board 2 to Security Mini-Sub



Figure 3: 11kV Cable Route Indication from Security Mini-Sub to ASQ Board 2

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

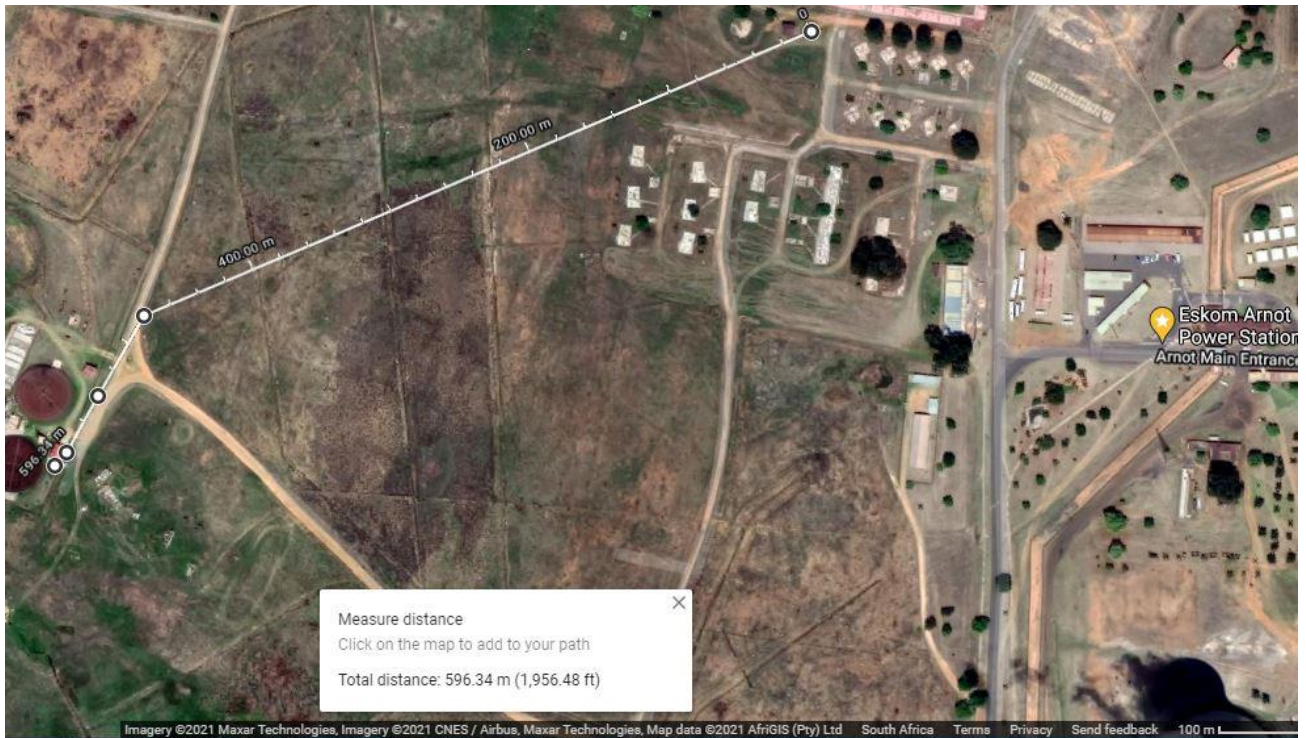


Figure 4: 11kV Cable Route Indication from ASQ Board 1 & Board 2 to Sewage Plant Board



Figure 5: 11kV Distribution Transformer 1 showing HV cable

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



Figure 6: 11kV Distribution Transformer 2 showing LV cables, HV Cable is on the other side



Figure 7: 11kV Standby-Set 3 & 4 HV Cable

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



Figure 8: HV Cables on Left Hand Side for 11kV Distribution Transformer 1 and 2 on Cable Racks

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



Figure 9: HV Cable of 11kV Standby-Set 3 & 4 Transformer on Right-Hand Side

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

6.5.3 Cables to be Tested

- a) Power Cables to be tested by the Contractor using the methods as listed in 6.5.28.2 and 6.5.28.3

Table 6: Cables to be tested by Contractor

From Station Board 1 to:
Interconnector to Station Board 2
CW pump North Reserve
Substation Board 1B
Substation Board 1A
11kV 400kV Relay House 1 Transformer
11kV 275kV Relay House 1 Transformer
11kV Conveyor Board 1
From Station Board 2 to:
Contractor Supply North
Contractor Supply South
CW pump South Reserve
Substation Board 2B
Substation Board 2A
11kV 400kV Relay House 2 Transformer
11kV 275kV Relay House 2 Transformer
Standby-Sets 5 and 6
Contractor Yard South
11kV Conveyor Board 2
Conveyor Boards
11kV Conveyor Board 2 and 11kV Conveyor Board 6
11kV Conveyor Board 6 and 11kV Conveyor Board 5
11kV Conveyor Board 5 and 11kV Conveyor Board 4
11kV Conveyor Board 4 and 11kV Conveyor Board 13
11kV Conveyor Board 13 and 11kV Conveyor Board 3
11kV Conveyor Board 3 and 11kV Conveyor Board 1
11kV Conveyor Board 2 and 11kV Conveyor Board 12
11kV Conveyor Board 12 and 11kV Conveyor Board 11
11kV Conveyor Board 11 and 11kV Conveyor Board 10
11kV Conveyor Board 10 and 11kV Conveyor Board 9
11kV Conveyor Board 9 and 11kV Conveyor Board 8
11kV Conveyor Board 8 and 11kV Conveyor Board 7
11kV Conveyor Board 7 and 11kV Conveyor Board 1
380V Conveyor Transformer 1 and 380V Conveyor Board 1
380V Conveyor Transformer 2 and 380V Conveyor Board 2
380V Conveyor Transformer 3 and 380V Conveyor Board 3
380V Conveyor Transformer 4 and 380V Conveyor Board 4
380V Conveyor Transformer 5 and 380V Conveyor Board 5
380V Conveyor Transformer 6 and 380V Conveyor Board 6
380V Conveyor Transformer 7 and 380V Conveyor Board 7
380V Conveyor Transformer 8 and 380V Conveyor Board 8
380V Conveyor Transformer 9 and 380V Conveyor Board 9
380V Conveyor Transformer 10 and 380V Conveyor Board 10
380V Conveyor Transformer 11 and 380V Conveyor Board 11
380V Conveyor Transformer 12 and 380V Conveyor Board 12

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

380V Conveyor Transformer 13 and 380V Conveyor Board 13
Sewage Plant
380V Sewage plant board
380V Sewage Effluent Board

- b) If it is found that after any of the above cables fail testing according to 6.5.28.2 and 6.5.28.3, the *Contractor* shall inform the *Employer* at the soonest time possible
- c) The *Contractor* shall refer to *Requirements for Control and Power Cables for Power Stations Standard 240-56227443 Rev 1* for a list of the full requirements, and utilise as much specifications as relevant for the cable replacement.

The *Contractor* shall ensure as a **bare minimum** , the following are adhered to :

6.5.4 Disconnecting Of Existing Cables

- a) All cabling that requires replacement according to Employer's latest revision Cable Schedules needs to be disconnected from the existing board/transformer and provided to Eskom.
- b) This includes, but is not limited to the disconnecting of all the Low Voltage (Control and Protection) , Medium Voltage (Power) and Low Voltage (Power) cables.
- c) All cabling (MV and LV) is identified and labelled (marked) before any cable is disconnected.
- d) All MV cables are disconnected at both ends for the purpose of testing the cables.
- e) The cable ends of all disconnected MV cables is protected against damage and the ingress of any water or dirt whilst being disconnected. The means of protection does not prevent the cable from being identifiable.

6.5.5 Reconnecting And Termination Of Cables

- a) All cabling is reconnected and terminated to the LV and MV Switchgear
- b) This includes, but is not limited to the reconnecting of all the Low Voltage (Control and Protection) , Medium Voltage (Power) and Low Voltage (Power) cables.
- c) Termination of cables includes all material and work required for terminating new and existing cables onto the switchboards.
- d) All MV cables are reconnected at both ends on completion of testing the cables.

6.5.6 Drilling Of Holes For Cabling Requirements

All incoming and feeding / outgoing circuits are designed to meet the cable slot requirements of the existing cables. If additional openings are required, the *Contractor* marks the cable entry holes or slots required. The position of the holes are determined by both *Contractor*, in conjunction with the Civil Engineer, and the size of the cable entry holes are determined according to the details of the amount and size of the cables as detailed in this document. The *Contractor* then drills the holes.

CONTROLLED DISCLOSURE

6.5.7 Site/ Ground preparation

The required areas of the site must be prepared adequately for the trench excavation. The location of the cable layout is according to the cable route, Figure 1 to 4 provided above. Debris, vegetation and other items not included in the drawing need to be cleared and disposed of in the relevant areas. Pavements and road surfaces (gravel) that lie on the region that needs to be excavated will be removed and reinstated by the *Contractor* as per the relevant standard and quality. The reinstated pavements and roads need to conform to the relevant standards and quality. For the areas where the cables are to be laid underneath a bridge, the surfaces are to be cleared of all residual ash and dirt to accommodate for the placing of cables in the area.

6.5.8 Excavation

- a) Trenches will be required only in the event that there is no existing trenches
- b) The trench is to be 0.8 wide unless extra care is required for placing of supports or components of the pipe. The trench is to be a minimum of 800mm deep.. A competent person must inspect the excavation daily before work commences.
- c) The contractor must dig test holes to verify the position of underground services and to assess the stability of the in-situ ground. If the stability assessed by the contractor is insufficient, he needs to provide shoring and bracing.
- d) Care must be taken as not to damage the surrounding buildings and services.
- e) There will be digging requirements from under all transformer bund walls to a depth of 1m, no excavator is to be used.

6.5.9 Repair / Replacement Of Damage To Existing Plant And Material

The ***Contractor*** is responsible for the repair / replacement of any damage to the existing plant and material caused by the *Contractor* during the execution of the work in accordance with the Scope.

6.5.10 Cable crossing other services

Please refer to Figure 10 and 11 for the locations and clearance distances. The protection provided at crossings need to extend 1m on either side of the crossing. Please take note of the position of the cable relative to the other services. The cable needs to be installed the same way.

Clearance	Protection required
More than 600 mm	  No further protection required
300 mm to 600 mm	  or   Cover tiles provided or cable installed in pipe
Less than 300 mm	  Concrete slabs or similar permanent separator required plus cover tiles

Figure 10 : Power cable running parallel to telecommunication cable

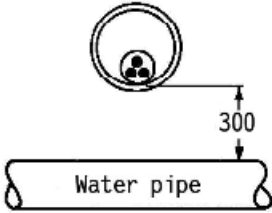
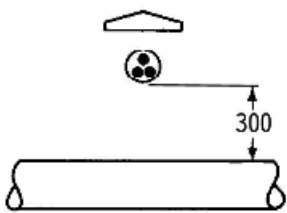
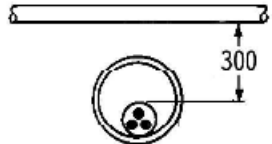
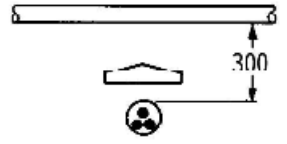
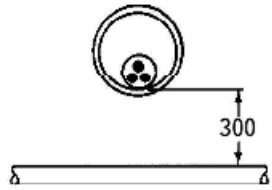
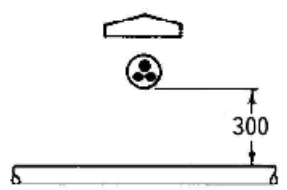
Crossing	Protection and clearance required
Above water pipe	 
Below telecommunication cable	 
Above telecommunication cable	 
All crossings	Cable laid in pipe or half pipes, or cover tiles provided for a distance of at least 1 m on either side of crossing

Figure 11: Power cable crossing other services

6.5.11 Road and two tier fence crossings

Where the cable crosses asphalt (tar) roads or the two tier fence, the cable must be installed inside a suitable black electrical cable sleeve. In respective of the two tier fence, it must be noted that re-enforced

concrete slab is instated where the electrical fence is situated. This sleeve must be installed by drilling underneath the road. No damage to the surface of the asphalt road or to any part of the fence will be accepted. The sleeve must extent 500mm further than the curbs on both sides of the road and 500mm on both sides of the fence. The contractor will be responsible for all drilling, supplying and installations in this regard. The detail of the fencings underground foundation is given in drawing 0.41/7 *Standard Security Fence*.

Where it is not possible to drill through the road, this must be clearly stated in the tender. A price for digging through the road and fence, and reinstatement to the original design must be given. The road design is given in 0.41/265 *Roads Layout Station Area*.

6.5.12 Bedding and backfilling

The *Contractor* must supply and lay all required bedding, covering, and backfilling, where in-situ material is not acceptable.

A 150mm layer of loamy soil must be provided for bedding and an additional 150mm for covering. No sand with a river or sea origin may be used as backfill. Where builders sand is used, the particle sizes need to vary and the thermal resistivity needs to be tested and confirmed as low.

The material excavated from the trench may be used as backfill above the covering only if:

- It contains minimal organic material
- Is able to pass through a 12mm sieve.

Backfilling must be placed and compacted in layers of 150mm. The covering may only be compacted using hand compacting tools.

The *Contractor* must supply and install marker tape, 200mm below ground level for the whole route of the cable.

6.5.13 Pulling of Power Cable

In order to avoid unnecessary cross-overs in joints, it is important to pull each cable in the same direction. Before attempting to lay the cable out, remove the cover over the inner end and so cut the lashing that the end is free to move. In case the end is not free buckling of the cable will occur. Take care to support the end as it works through the flange.

6.5.13.1 Cable pull cards

The Cable schedule specifies the cable type, source and destination of each cable.

The *Contractor* routes each cable in terms of route segments and rack or tray layers traversed. The *Contractor* forwards all routing for acceptance. These are completed with the *Contractor's* information upon laying and termination of each cable. The *Contractor* is responsible for a cable pull card system recording the following: (Sample with minimum requirements attached)

- a) From end to end of each cable
- b) Cable type installed
- c) Cable type existing (where cable is extended)
- d) Cable number
- e) Identify termination and joints

CONTROLLED DISCLOSURE

- f) Length of cable installed.
- g) Termination drawing number.
- h) Name of cable jointer and terminator.
- i) Joint and termination kits number.

6.5.13.2 Direction of drum rotation

The drum must be arranged that the cable leaves the top of the drum as indicated in Figure 12. To minimise the tension on the cable, rotate the drum by hand and use a wooden plank to slow down and brake the drum.

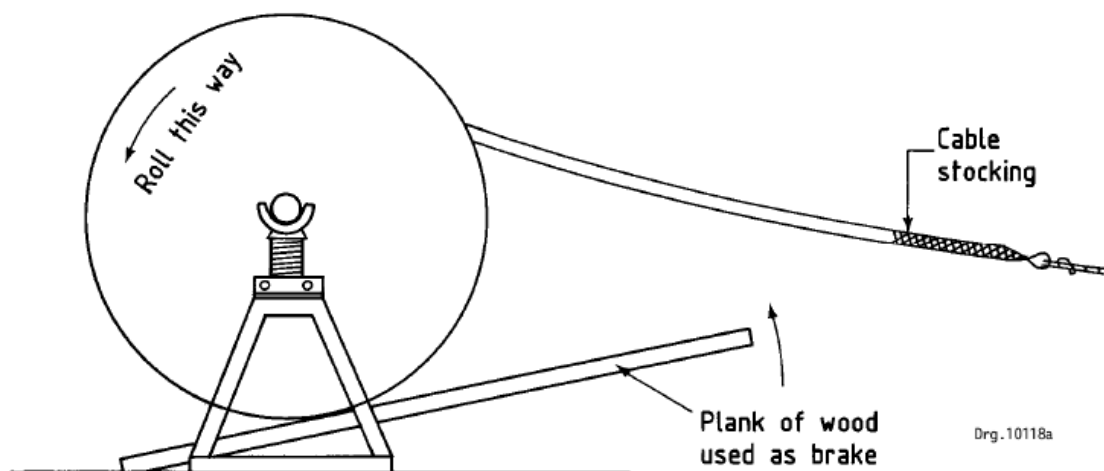


Figure 12: Arrangement of cable drum

6.5.13.3 Intermediate storing of cables at site

As the cable drums may have to be stored in the open storage area for extended periods it is necessary to protect the cable on both new and opened drums against climatic influences.

Drums are not stored directly on the ground but on wooden or other approved beams to permit drainage of rainwater and prevent the rotting of the drums. To protect the outer cable layer against UV-radiation, slats are not removed from the unused drums. Drums returned to the area after some of the cable has been utilized are protected against deterioration of the outer cable layer through UV-radiation by an adequate means or the drums are stored indoors.

The *Contractor* endeavours to plan his cable deliveries in such a way that only cable to meet his immediate and short term needs within the construction program is stocked on site

6.5.14 Labelling

- a) All cables shall be labelled with standard UV resistant PVC K Type flexible cable markers on nine digit carrier strips and attached on both ends with suitable cable ties

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- b) Cable numbers for application in chemical corrosive environments or outside buildings e.g. coal and ash conveying plant shall be stainless steel with engraved black letters and numbers and fixed with stainless steel wire
- c) The cable types shall be designated in accordance with the codes detailed on the following drawings: *0.00/1310 Standard power and control cable code*
- d) Use drawing *26.41/37814 Cable Number Tag Details, Sheet 1*

6.5.15 Medium voltage power cables

- a) 3-core cables shall be with the cores individually screened with copper tape
- b) All armoured single core cables in trefoil groups shall be earthed on one side only in order to prevent armour circulating currents flowing through closed circuits. Single point earthing shall be carried out on the feeding side of board to board feeders or on the normal side of supply in a ring feeder section.
- c) On feeds from a board via a transformer to another board (typical example: 11 kV board to transformer to 6.6 kV board) the cable armouring shall be earthed in the boards only.

6.5.15.1 Voltage rating

For the 11 kV system the rated cable voltage is 6.35/11 kV

6.5.15.2 Terminations

- a) Approved termination kits for terminating MV cables shall be supplied. Care shall be taken to ensure that the dimensions and procedures issued with the kit are adhered to.
- b) MV Cable cores are colour coded by means of red, white and blue heat shrink.

6.5.16 Low voltage power cables

- a) This range of cables shall be round steel wire armoured for burial in ground and for installations where mechanical stresses are expected and shall be used for control cables (DC: 220 V, AC: 230 V) and power cables (230 V, 400 V AC).
- b) In the cable size range of 35 mm² to 185 mm² 3 1/2 core cables with a neutral core approximately 1/2 of the cross sectional area of the phase conductors shall be used.

6.5.16.1 Low Voltage Power cable terminations

- a) Cables of larger rated areas terminated straight onto the terminals of the lowest drive compartment in a MCC may give problems due to heat expansion. An S-bend or a complete loop shall be provided

CONTROLLED DISCLOSURE

near the termination so that expansion due to temperature changes does not stress the cable or terminal.

6.5.17 Cable racks

**See Figure 8 and 9 for cable racks*

- a) Cable racks shall be provided such that every cable is adequately supported throughout its run. Racking for power cables and control cables shall be designed to support the cables at least every 375 mm. Control cables may have to run on cable trays or in ducting so that they are supported over their entire length.
- b) The minimum spacing between open telephone, control and instrumentation cable racks and power cable racks shall be 1000 mm. This may be reduced at crossings, which is at right angles. Where limited space makes it necessary to bring power and control cable racking closer than 1000 mm, control cable trays shall be installed and closed by means of a suitable cover to create a Faraday cage around the control cables.
- c) Separate racks or trays shall be installed for cables of the following voltage levels:
Power cables 6.6 kV and 11 kV in trefoil configuration
Cables in trefoil configuration shall be clamped with non-magnetic clamps capable of withstanding forces generated by short circuit currents in accordance with paragraph 11.3. The normal centre line distance between clamps shall be 750 mm but clamps shall be fixed to the racking only every 3000 mm.
- d) For field mounted runs, in particular for small power and control cabling, cable trays manufactured from high tension wire mesh shall be acceptable. These trays are less prone to collection of dust.
- e) If additional racking is required to accommodate the new cables, it is the *Contractor's* responsibility to design the hardware, i.e. select light, medium or heavy duty ladder racks or trays, including all unistruts, racking, trays and tray supports in a cost effective manner.

6.5.18 Cable route markers

- a) Cable route markers shall be in accordance with drawing 26.41/45 *Cable Route Marker Detail* provided by the *Contractor* to mark all cable servitudes and the general location of buried cables. The route markers shall be located at 50 m intervals and wherever a route changes direction, to mark buried joints and where cables cross roads, railways, any other servitudes and the Security Electric Fence.
- b) There is no cable number on the cable mark, required is the following information on the cable mark: where the cable is from and where the cable is going to.

CONTROLLED DISCLOSURE

6.5.19 Cable Joints and Terminations

- a) The cable joints and terminations shall be done according to the Eskom Standard 240-56227443 (Requirements for Control and Power Cables for Power Stations Standard). The cable joining and termination method for XLPE to XLPE cable which is supplied inside the jointing kit shall be used and the contractor must supply a QCP in accordance with the specific joining method.
- b) Where practicable, snake the cables on either side of each joint position to relieve the joints of any thermomechanical stresses.
- c) Most of the trench needs to be backfilled before joining starts. Joint bays need to be created by the contractor. They must be 3m long, 1m wide and 300mm deeper than the buried cable. The sides need to be draped with tarpaulins or plastic sheeting to prevent loose material from falling into the trench during joining operations.
- d) Terminations / joints are made in a professional manner, particular attention being paid to the cleanliness of tools, material and working site. No mineral-insulated cable termination is left unfinished overnight after the sheath has been removed.
- e) No through joint may be installed within 5 000 mm of a bend.

6.5.20 Termination through gland plates

- a) Where cables enter enclosures through gland plates, mechanical cable glands of the armour or cable gripping type to SANS 1213 shall be used. Glands shall be of the correct size for the cable. Weatherproof shrouds shall be required only for exposed positions indoors and for all field mounted terminations.
- b) The quality of cable gland terminations shall be in line with and may not be lower than the degree of protection (IP rating) of the enclosure against ingress of dust and water.
- c) For MV cables where cable glands are required, split gland plates shall be provided to enable removal of the cable without removal of the gland plate.
- d) For single core cable terminations the gland plate and both gland and lock nut shall be of non-magnetic material.
- e) Cables shall be installed from the back to the front on the gland plate to enable cables to be added without difficulty at a later stage, if required. Low voltage and control cables shall be grouped separately on the gland plate.
- f) Outdoor cables shall not enter at the top of a distribution board and where cables enter on the side, care shall be taken to prevent water ingress

6.5.21 Termination of cables in switchboards

- a) Where cables (larger than 70 mm²) enter switchboards or other cubicles through floor openings, which will later be closed by adequately fire rated material to make them also vermin proof, gland plates shall not be considered as essential. In that case the switchboard manufacturer is held

CONTROLLED DISCLOSURE

responsible for providing unistrut or similar rails to which cables can be securely clamped by the cable contractor by means of “K-clamps” or approved equivalent. Non magnetic clamps shall be used for single core cables.

- b) Where space within the switchboard is limited, the unistrut shall be installed below the floor level and the cables shall be fixed to this unistrut with K-clamps.

6.5.22 Earthing of equipment and cables

- a) For detailed instructions on the earthing methods when terminating cables, screens etc, refer to the section 3.7 “Earthing and lightning protection” .

6.5.23 Cable lugs and crimping tools

- a) The size of cable lugs shall be selected to fit the bare copper conductors on which they are used.. All small lugs shall be crimped by means of the correct crimping tools. Crimping tools shall either be of the manual or hydraulic type. Only standard pre-fabricated crimp lugs shall be used. Cutting, re-drilling and other site modifications shall not be allowed. Pre-insulated crimp lugs with unbrazed barrels shall not be crimped sideways.
- b) Larger cable lugs shall be to the SABS specification, i.e. the material body of lugs shall not be less than the rated area of the conductor. For carrying out compressed joints or terminations on cables above 16 mm² rated area a suitable hydraulic compression unit complete with the necessary dies, compression head, hose and pump shall be used. Crimping dies shall produce a hexagon shaped crimp. Crimps with a deep central indent in the lug shall not be acceptable. The hydraulic pump unit and compression head must feature an interlocked valve system which can only be released when the compression operation has been fully executed.
- c) For high fault current applications above 40kA heavy duty lugs with double crimps shall be used.
- d) Cable cutters shall be used to strip flexible stranded cable, not a hack saw as this creates distortion in the cable.
- e) *26.41/37564 Switchgear Cable Lug Standard Dimension*

6.5.24 Torquing of Connections

Torque wrenches are to be used to tighten screw-joints of copper bars as well as bolting cable lugs onto copper bars to consistent and repeatable values.

High tensile M12 and M16 bolts of tensile strength 8,8 (class 8g) and nuts of strength 5 are to be used. Bolts with tensile strength 5,6 (class 5d) are not acceptable. The *Contractor* must supply all bolts, nuts, flats and spring or contact washers for terminating power cables onto boards and other equipment, e.g. transformers.

CONTROLLED DISCLOSURE

6.5.25 Sealing Of Holes In Floors And Walls

- a) Wherever cables pass through holes or slots in floors and walls or enter or leave sleeve pipes in floors or walls; the openings shall be sealed with vermiculite plaster or other material approved by the Engineer. This material shall be domed or slightly raised towards the centre to prevent the accumulation of water or oil in the seal. The sealing material shall be water resistant and provides a barrier for smoke and toxic fumes.
- b) Waterproof fire seals are separately priced and only installed in places indicated by the Employer.
- c) In the case where cable sheaths are incompatible with barrier material, the cable shall be protected through the floor or wall by instamatic paint so that the sealing material is not in direct contact with the cable at any point.

6.5.25.1 Sealing of switchgear Cable entries.

The sealing of the cable in the switchgear is in compliance with the pressures that are occurring during an internal arc within the cable compartment.

6.5.25.2 Temporary Fire Barriers

Where an opening in fire barriers cannot be permanently closed due to the need to install further cables, the *Contractor* to install temporary fire seals by means of approved sealing bags at important break-throughs.

6.5.25.3 Permanent Fire Barriers

The entire Power Station and in particular the cable basement are divided into fire cells. Cables have to cross barriers between cells out of necessity.

It is thus important to re-seal such penetration points permanently once cabling activities have been completed in an area.

Fire barriers to be installed by the *Contractor* The material used has a 2-hour fire rating under all installation conditions.

The *Contractor* proposes one or more systems approved either by the SABS or the CSIR to fulfil this condition indicating the thickness of material required.

There are 3 categories of seals:

- Un-reinforced seals for small holes (less than 300-mm diameter).
- Lightly reinforced seals where the size of the hole to be closed requires some non-magnetic reinforcing in order to support the fire rated sealing material.
- Reinforced seals for larger holes (or smaller seals called upon to carry the weight of persons of say 100 kg).

It is self-evident that seals under 2 and 3 may have to be thicker than that under 1.

The responsibility for timely installation of such fire barriers rests with the *Contractor*.

6.5.26 Closing of cable entries to buildings and transformer bays

- a) Once cabling work is completed the *Contractor* shall request permission from the Engineer to close up all cable entries leading from inside buildings directly into ground outside, as well as those from transformer bays. These are made watertight by applying bituminous paint over the outside plaster.

CONTROLLED DISCLOSURE

- b) This prevents ingress of vermin into the cable trenches or cable basement as well as entry of rainwater carrying silt and debris with it. Flooded cable basements can lead to premature failure of electrical equipment.

6.5.27 Closing of Unoccupied Cable Slots in Switchgear Rooms

Where floor openings or cable slots are not occupied by switchboards etc. they are closed by the *Contractor* with Vastrap plate after a reinforced fire seal has been installed. For openings up to 500 mm wide the thickness of the Vastrap plate is 4,5 mm, for openings above 500-mm wide 6 mm Vastrap plate is used unless 4,5-mm plate can be suitably stiffened.

Such covers are fabricated and paint finished. Flat or angle iron stiffeners are strip-welded to the plate underside to prevent covers slipping off the openings being covered. The covers are bolted to the floor.

6.5.28 TESTING AND COMMISSIONING OF CABLES

All electrical testing equipment shall be supplied by the *Contractor*

All test results are presented in a file labelled "Cable Test Results"

6.5.28.1 Type Testing

It is required to provide type test certificates of each type of cable used. The type test certificates are to include the cable terminations and cable joints.

The following tests are a minimum requirement to appear on the type test certificates.

- AC withstand 20 kV
- Impulse withstand 60 kV
- Partial discharges
- Load cycle and heat run
- Short circuit 25 kA (specify time)
- Mechanical properties and bending

6.5.28.2 Insulation Resistance

- a) All cable tests shall be witnessed by the Employer Engineer. The cable tests shall be done according to the Eskom Standard 240-56227443 (*Requirements for Control and Power Cables for Power Stations Standard- 3.8 Testing and commissioning of cables*). An Insulation Resistance and a High Voltage test after each joint of the cable are required with the minimum required Insulation results.
- b) The insulation resistance of each core to sheath or conduit and between cores of all cables shall be measured and recorded after the cable has been installed and made off.
- c) For each cable termination the person carrying out the job shall print and sign his name, enter the date on which the work is carried out and records the insulation readings in the appropriate place on the cable pull card.
- d) For a cable to be deemed healthy the resistance readings obtained from the Cable Pressure Test, shall be LV > 5MΩ and MV > 500MΩ and it should be able to withstand the rated cable voltage

CONTROLLED DISCLOSURE

applied without any breakdown occurring for a new cable. Existing cables to be tested with 70% of the cable rated voltage and it should withstand without any breakdown.

- e) The minimum insulation reading shall not be less than 50 MΩ
- f) Due to the nature of the cables, the *Contractor* shall pressure test new cables to the rated voltage and for old cables to 70% of the cable rated voltage only using the VLF (0.1Hz) Method , so as to not cause damage to the aged cables

6.5.28.3 High voltage tests

- a) Cables rated at 6600 V and above shall be high-voltage tested after installation.
- b) Through- or tee-joints which are installed in an existing cable shall be subjected to a high voltage test before being put into service. The cost of such a test is included in the rate price for the joint.

6.5.29 Commissioning

- a) The commissioning of any plant will only be done after all cable tests have passed and reports are handed over to Eskom for final approval whether it be for new cables, cables that have been joined or cables that are existing.

6.6 LIGHTING AND SMALL POWER INSTALLATIONS

- a) All permanent lighting and small power installation systems will be provided by the *Employer* in compliance with the following standards as the minimum:
 - 240-55714363 Coal Fired Power Stations Lighting and Small Power Installation Standard.
 - OHS Act: Occupational health and Safety (latest revision).
 - SANS 204: Energy Efficiency in Buildings.

6.7 EARTHING AND LIGHTNING PROTECTION

- a) The *Contractor* shall design, procure, install, test, commission and handover of new earthing and lightning protection system for the new equipment installed. This equipment will include electrical equipment provided as part of this Specification.
- b) The *Contractor* designs earthing and lightning protection systems in accordance with 240-56356396 Earthing and Lightning Protection Standard.
- c) Earthing and lightning protection shall be in a form of bonding to the station earth mat which includes all necessary tests such as continuity tests.

6.8 CONTROL AND INSTRUMENTATION

A. Station board 1 and Station board 2

The signals that will be monitored and controlled at the SOR for station board 1 and station board 2 are listed in Appendix F.

The *contractor* shall design, install, configure, and commission the above signals from both station board 1 and 2 to the SOR screens. The installation shall have the following specification:

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- Fiber Network: Single Mode
- Cable Protection: P2000 Unistrut with galvanised covers.
- Fibre Switch and Patch Panel shall have these features:
 - Up to 24 fibres in 1U
 - Multiple Adaptor options available
 - 12 Adaptor positions
 - Individually labelled ports
 - 45° open working angle
 - Accepts loose tube, distribution and pre terminated cables
 - RoHS, REACH SvHC and UL rated
 - Fits standard 19
 - Switch: 4-Port Ethernet L3 Fully Managed Pro Switch, 20 x 10Gb SFP+, with 4 x 25Gb SFP28 and 2 x 40Gb QSFP+ Uplinks, Stackable Switch.
- 19" Rack in Sub Station: 12U Wall Mount.
- The existing ASF Switch in IDF Room shall be used aswell as the existing ABB SCADA configuration and software engineering.
- The Communication protocol to be used is the IEC 61850 Ed1 and Ed2.

Figure 13 below depicts depicts the MicroSCADA configuration that the *Contractor* shall configure the system according to.

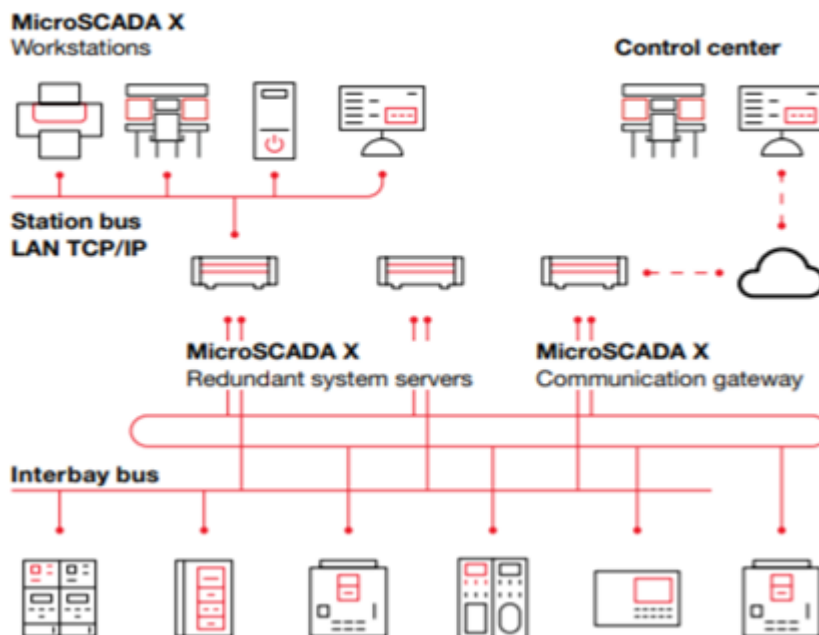


Figure 13: MicroSCADA configuration

The Contractor shall use the following communication and interface solution libraries for efficient integration with protection and control IEDs:

Master protocols:

IEC 61850 Ed1 and Ed2, IEC 60870-5- 101/103/104, DNP 3.0 TCP/serial, Modbus TCP/RTU, LON, SPA, RP 570/1, ANSI X3.28, I35/P214, ADLP 180, IEC 61107.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Slave protocols:

IEC 60870-5-101/104, DNP 3.0 TCP/serial, Modbus TCP/RTU, RP 570/1, ADLP180, F4F. Ethernet redundancy according to IEC 62439/PRP

Open interfaces:

OPC, OPC UA, ODBC, application programming interfaces for application and communication extensions Data concentration and signal grouping and control IEDs GPS time synchronization.

B. Conveyor board 1 and Conveyor board 2

The signals that will be monitored at CSY Control Room for Conveyor board 1 and Conveyor board 2 are listed in Appendix F.

The *Contractor* shall design and configure the above signals as per the following specification

The communication form Coal Conveyor Boards 1&2 Protection Relays will connect to the new Switch Panel in Conveyor Board 1&2 that must be connected via fibre network to the existing Switch Panel in Conveyor Sub 1&2 that is connected to the CSY Control Room Server.

The following criteria will apply:

- The Switch Gear Protection will be monitoring only.
- Communication protocol to the Siemens RTU is Profi-bus.

Installation Specification:

- Fiber Network: Single Mode
- Cable Protection: P2000 Unistrut with galvanised covers.
- Fibre Switch and Patch Panel:
Features:
 - Up to 24 fibres in 1U
 - Multiple Adaptor options available
 - 12 Adaptor positions
 - Individually labelled ports
 - 45° open working angle
 - Accepts loose tube, distribution and pre terminated cables
 - RoHS, REACH SvHC and UL rated
 - Fits standard 19
 - Switch: 4-Port Ethernet L3 Fully Managed Pro Switch, 20 x 10Gb SFP+, with 4 x 25Gb SFP28 and 2 x 40Gb QSFP+ Uplinks, Stackable Switch.
- 19" Rack in Sub Station: 12U Wall Mount.
- Switch in Conveyor Board 1&2: Existing.
- Scada configuration and software engineering – Adroit Scada is running in the CSY Server where the Switch Gear Protection Face plate must be generated and also set up the alarms, historical trending and reporting logs.
- HMI and Mimics –Generate Mimic pages on the Conveyor Control screen.

6.9 LOW PRESSURE SERVICES

The *Contractor's* HVAC discipline is responsible for the detailed design; plant and material selection; installation and as built drawings; testing, and commissioning documentation; operating instruction and maintenance manuals of the complete HVAC Works.

The *Contractor* is to submit the detail design for the HVAC scope for acceptance. *Employer's* HVAC department to review the designs submitted by the *Contractor* and sign it off for acceptance. The affected buildings includes the following as indicated by accompanying tender drawings:

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- a) Station boards 1&3 and 2&4; and
- b) Conveyor board 1&2

The Employer's HVAC department supplies the following basic design details that should be used by the *Contractor* as a starting point for the detailed design. The *Contractor* is to engage the *Employer* if any changes are required to achieve the design requirements.

Table 7. Summary of room dimensions and existing ventilation.

Room	Length (m)	Width (m)	Height (m)	Current ventilation
Conveyor board	15	5	4	Pressurizing fan. Not in working condition.
Each station board (2&4 and 1&3)	26	5	4	Natural ventilation holes alongside outside wall.

6.9.1.1 Conveyor board 1&2 ventilation requirements

The pressurizing fans for boards (excluding station boards) to have two air changes per hour for pressurization. [10] Table 8 can be used to calculate required air changes.

Filter efficiencies are to be in accordance with one of the below: [10]

ASHRAE 52.1 – 85% dust spot efficiency;

ASHRAE 52.2- MERV 13;

EN 779-2011- class F7

6.9.1.2 Station boards ventilation requirements

The component power consumption, given in section **Error! Reference source not found.**, was used or the basic design heat load calculations. The general assumptions made for other variables used are given in Table 89.

Table 8. Station board ventilation basic design assumptions.

Variable	Value
Maximum operating temperature	40 °C Error! eference source not found.
Maximum ambient temperature	30 °C Error! eference source not found.

CONTROLLED DISCLOSURE

C_p - specific heat of air	1 kJ/kg K [10]
C_d - Discharge coefficient for opening weather lovers	0.62 [10]
ρ – Density of air	1.2 kg/m ³ [10]
U – Coefficient of thermal conductivity	1.98 W/m ² Error! eference source not found.

The total heat input into the switchgear rooms was calculated and a combined heat input of $Q_{tl} = 3.459 \text{ kW}$ was found. **Error! Reference source not found.**

Basic assumptions made:

- Heat from outside air – Outside air assumed cooler – Neglected;
- Heat from installation and personnel heat (section **Error! Reference source not found.**);
- Heat from radiation heat from areas exposed to sun – One wall exposed to sun;
- Heat from outside loads – Negligible;

The required air flow for heat removal is calculated and results in a value of $\dot{V}_{req} = 0.288 \text{ m}^3/\text{s}$. [10]

Using the required air flow for heat removal, the natural ventilation flow rate for buoyancy-driven natural ventilation with vents at two different heights (3m height difference) an estimate of the cumulative vent size required to achieve that flow is calculated to be $A = 0.171 \text{ m}^2$. [10]

Table 9. Summary of basic design ventilation requirements.

Room	Current ventilation	Additional requirements
Conveyor board 1&2	-	Replace with new pressurizing fan.
Each station board (2&4 and 1&3)	Natural ventilation holes alongside outside wall. Covered with appropriate louvers and weather louvers.	Ventilation hole area to have total inlet area of 0.171m ² . Inlet area = Outlet area.

6.10 CIVIL AND STRUCTURAL

There are a total of 16 separate buildings in which the switchgear equipment to be replaced is housed. Station Boards 1 & 2 are located in the same building within the main building in separate rooms and all the remaining switchgear boards are located in separate miscellaneous substation buildings located throughout the power station.

The following switch gear boards will be replaced in the following substation buildings:

- i) Main Building (Station Board 1 and 2)

CONTROLLED DISCLOSURE

- ii) Arnot Single Quarters Substation Building (Arnot Single Quarters Board 1 and 2)
 - iii) Sewage Plant Substation Building (Sewage Plant Board 1 & 2)
 - iv) Coal Conveyor Substation Buildings 1-7 (Coal Conveyor Boards 1-13)
- a) The *Contractor* performs a complete site inspection of all the switchgear rooms including a detailed structural assessment of the existing structural slabs, foundations and walls in order to assess the scope and constructability of the project before commencing with any design or construction work.
- b) The *Contractor* provides a detailed design report including all design calculations and construction drawings pertaining to the scope of this project.
- c) The *Contractor* is required to submit a comprehensive method statement of the works to the *Project Manager* for acceptance prior to the execution of the works
- d) All details and drawings of any buildings and civil works which are not explicitly included in this contract but which, in the opinion of the *Contractor*, will be necessary for the completion and proper execution of the project is included by the *Contractor* and submitted to the *Project Manager* for acceptance. The *Contractor* clearly indicates his proposed scope regarding these additional items.
- e) All drawings provided with this *Employer's* Works Information are for information only and any validation required will be responsibility of the *Contractor*. Wherever changes are made to the existing infrastructure it remains the responsibility of the *Contractor* to update all the existing drawings of those areas to an as-built status.
- f) The *Contractor* identifies and specifies all work and tests to be conducted prior to construction.
- g) The *Contractor* ensures that the implementation of the project does not compromise the structural integrity of any of the existing systems or equipment on site.
- h) All the Civil and Structural design and construction work required during the execution of this scope is the responsibility of the Contractor. The Civil and Structural design and construction work is executed in accordance with 240-56364545 - Structural Design and Engineering standard. Design loading is in accordance with SANS 10160.
- i) Ventilation is required for Station Boards 1&2, the new switchgear equipment will require ducting leading to the outside environment. The sizes of the arc duct will be provided by Others (MV switchgear Contractor). The identified desired locations for the openings are on the Northern wall of switchgear room 1&3 and the Southern wall of room 2&4.

CONTROLLED DISCLOSURE

6.11 DECOMMISSIONING AND CONSTRUCTION

6.11.1 Decommissioning

- The *Contractor* decommissions, removes, and dispose off the existing switchgear and protection contained in the equipment list to an area designated by the *Employer*.
- The *Contractor* decommissions, removes, and dispose off the existing bitumen filled terminal box on the LV side of the CW Transformer to an area designated by *Employer*. The removed bitumen filled terminal box contains substances which can be harmful to the environment thus the *Contractor* shall dispose them as per the waste management procedure ASEN 0008.
-

6.11.2 Construction and erection phase

- a) The *Contractor* constructs and erects the *works* in accordance with the *Employer's* approved design.
- b) All *works* are to be performed in accordance with the *Contractor's* accepted Quality Control Plan. All construction and erection work conducted on the site is subject to inspection by the Supervisor.
- c) The construction and erection of the *works* is to be performed under the supervision of the Supervisor. An acceptance/test schedule is compiled by the *Contractor* and approved by the Supervisor.
- d) All equipment required for the erection and completion of the *works* is to be supplied by the *Contractor*. This Equipment is to be in good condition and subject to the *Employer's* safety requirements.
- e) The *Contractor* supplies all Plant and Materials where new Plant and Materials are required for the completion of the *works*.
- f) *Contractor* shall install the new air filled terminal box and interface it with the new differential protection, installation shall be as per SANS 876
- g) *Contractor* shall perform wiring of protection cables the new terminal box up to the Station Board (NR SR) protection scheme.

6.11.3 Temporary *works*, Site services & construction constraints

The *Employer* will provide construction power at a central point of supply near the Works, from which the *Contractor* shall access power. The *Contractor* provides distribution of construction power from the point of supply to areas where power is required during construction.

Station board 1 and 2 are the main supply points for outside plants. Losing either board 1 or 2 might interrupt the power production process. Prior to commencement of installation, the *Contractor* shall make provision to supply all loads downstream of station board 1 and 2 which are not redundant; the station

electrical reticulation diagram (0.41/304) indicates which loads are not redundant. The method statement below indicates how the *Contractor* is to carry out this *Work*.

Most critical loads downstream station board 1 and 2 are redundant. Thus, supply to either board 1 or 2 will be maintained whilst working on either board; the only loads that are not redundant downstream are standby sets, contractor supply, CW reserves. Two new mobile RMUs specified on the equipment list will be connected to make up a board of 3 circuit breakers with input supply from either station board 1 or 2 depending on which board is in service. These RMUs will supply loads that are not redundant downstream station board 1 or 2.

The coal conveyor plant has a ring feed, which makes it easy to work on the boards. The conveyor plant's strategy is that the above mentioned RMUs will be used to supply loads of the board being worked on at the time. The mobile RMUs will later be installed as indoor RMU for the last board to be installed.

7. INFORMATION REQUIREMENTS

7.2 GENERAL

Submission of information which conveys the quality, quantities and operational capabilities are required.

7.3 SYSTEM DESCRIPTIONS AND PHILOSOPHIES

The *Contractor* provides written plant design descriptions, the plant design philosophy and plant operating and control philosophies.

7.4 DOCUMENTATION AND CONFIGURATION MANAGEMENT

7.4.1 Document Management

All documents supplied by the *Contractor* shall be subject to Eskom's approval. The language of all documentation shall be in English. The *Contractor* shall include the *Employer's* drawing number in the drawing title block. Drawing numbers and document numbers will be assigned by the *Employer* as they are developed. All documentation shall be controlled and managed in accordance with Document and Records Management Procedure (32-6).

7.4.1.1 Document Submission

The *Contractor* is required to submit documents in electronic and hard copies and both copies must be delivered to the *Employer's* Representative with a transmittal note. Electronic copies shall be submitted to the *Employer's Representative* Email subject; **Project Name_Discipline_Subject**. Electronic copies that are too large for email will be delivered on large file transfer protocol and/or hard drives to the Project Documentation Centre. A notification email, with the transmittal note attached, shall be sent to the *Employer's Representative*.

7.4.2 DRAWINGS FORMAT AND LAYOUT

All drawings submitted by the *Contractor* shall be in a following format.

Electronic Format of the Drawings

All drawings must be issued to Eskom Micro-Station drawing (DGN) format. No other electronic drawing formats will be accepted as well as a set of hard copies.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Paper format of Drawings

- All printed drawings must be printed utilizing the standard Eskom. Pit Micro-Station driver file.
- All paper drawings must be clearly printed on the minimum of 80mg/m2 bond paper.
- All the drawings issued to the Eskom in paper format must comply to the following paper sizes:

Table 10: Drawing paper sizes

	Paper Sizes[mm]	Usable Sizes[mm]
A0	118X841	1154X830
A1	841X594	830X559
A2	594X420	583X385
A3	420X297	409X262
A4	297X210	286X175

- The define the extend of the available print area usable sizes
- The standard tile block file has been set up in accordance with the usable sizes.
- The standard seed file defines paper sizes to be utilized when inserting Scanned images into a CAD Drawing.

7.4.3 PLANT CODING AND LABELLING

• PLANT CODING

Upon receipt of updated drawings, the *Employer* will create new KKS codes for the new equipment. The existing plant codes shall be used on replaced objects, the MV switchgear plant coding sequence shall be followed for the new switchgear. Plant coding shall be undertaken by the *Employer* using the KKS Plant Location Coding Standard 240- 40643427.

• PLANT LABELLING

It is the responsibility of *Employer* to manufacture and install KKS coded equipment's labels in the plant. Labels are manufactured and installed according to the Label Specification and Plant Codification Work Instruction (240-64550692). *Employer* will label all KKS coded equipment.

7.5 DESIGN REVIEW OF ELECTRICAL SYSTEMS

- a) The *Contractor* shall hold a design review as part of the compliance review of the plant, allowing the *Employer* to gain a clear understanding of the overall design.
- b) The review shall be after the completion of the design, the preliminary outline drawings, and the rating plate drawings.
- c) The *Contractor* shall demonstrate how the Plant functions reliably within the operating requirements and meet the performance guarantees. The *Contractor* will make available documentation for on-site review.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- d) Prototype features in the design or fabrication shall be highlighted and assessed for risk and reliability. Items found not in compliance with the Contract documents will require rectification.
- e) The *Contractor* shall make available the calculations and information for the detailed design verification. This part of the design review will take place in the *Contractor's* design offices. The *Employer* shall advise on the appropriate venue.

7.5.1 Design Review Procedure

The *Contractor* is the Design Authority as defined in the Design Review Procedure (240-53113685). The *Contractor* is responsible for following this design procedure and conducts all the design reviews as specified in this procedure. The *Contractor* is responsible for conducting the following design reviews:

- a) Design Freeze Review
- b) Integrated Design Review
- c) Construction Completion Review
- d) Acceptance Testing Review

7.5.2 Engineering Change Procedure

The *Contractor* takes note of the *Employer's* Project Engineering Change Management Procedure (240-53114026). An engineering change includes any proposed change originating from engineering, contractors, project management or construction management.

8. STORAGE AND PRESERVATION

The *Contractor* shall :

- a) Adhere to the OEM storage and preservation requirements.
- b) Indicate any deviations to the *Employer's* 240-137465740 Standby Battery Storage and Commissioning in Eskom Standard for acceptance by the Employer.
- c) Liaise with the *Employer* to align manufacture delivery schedules to avoid the extended storage and preservation of cells.
- d) Make provision for storage and preservation of the equipment at the local premises.
- e) Formally notify the *Employer* of cells requiring rejuvenation due to extended storage.
- f) The cost of storage and applicable preservation requirements at the *Contractor's* local premises shall be indicated in applicable financial schedules.

8.1 TRANSPORTATION, DISPOSAL AND INSTALLATION

- a) The *Contractor* is responsible for the transportation of cells in accordance with 240-89797258 The Safe Handling, Transportation and Disposal of Cells standard. Off-Loading Equipment
- b) The *Contractor* shall be responsible for off-loading the equipment at the site and transporting the equipment from the point of off-loading to the point of installation. Any special tools and equipment to be used on site for the execution of the work shall be supplied by the *Contractor*.
- c) The *Contractor* is responsible for the off-loading of equipment in the common and outside plant areas and transporting the equipment from the point of off-loading to the point of installation.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- d) The *Contractor* is responsible for the off-loading of equipment in the common and outside plant areas and transporting the equipment from the point of installation to the point of disposal as per the waste management procedure ASEN 0008.

8.1.1 Equipment Rigging

Rigging facilities are available on *Employer's* site but the *Contractor* shall assess the available rigging facilities on site prior to the delivery of equipment if the rigging facilities are suitable for their equipment. Arrangement for using the rigging facilities must be made in advance (i.e. at least two weeks prior to the required date).

The *Contractor* shall provide a transportation and rigging schedule indicative of the equipment weights and dimensions to the Employer.

9. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Nothando Mdletshe	LDE electrical
Dikeledi Zitha	Senior Engineer Electrical
Claude Chetty	EDWL
Cameron Govender	System Engineer Electrical
Wouter Tempel	LDE C&I
Kesh Mahabir	LDE Civil & Structural
Charl Coertzer	LDE LPS
Fred Claassens	Asset management senior consultant
Vonani Mathebula	Chief Engineer
Michack Sedibe	Technician

10. REVISIONS

Date	Rev.	Compiler	Remarks
June 2021	0.1	N Mdletshe	Draft
July 2021	1	N. Mdletshe	Document required for SCCC presentation

11. DEVELOPMENT TEAM

The following people were involved in the development of this document:

Cameron Govender

Charl Coertzer

Kesh Mahabir

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

12. ACKNOWLEDGEMENTS

- Makgatle Lentsoane

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX A: SINGLE LINE DIAGRAMS

Item	Document No.	Document Description
1	0.41/304	Medium and Low voltage electrical boards station diagram
2	0.41/3728 sheet 2	Medium and Low voltage station diagram
3	0.41/13326	11 kV compound board 1 drawing
	0.41/39988	Medium and Low voltage single single quarters electric diagram SLD
4	26.41/37085	HV Distribution Mimic Panel Layout
5	0.41/3351	Overland Conveyors cable block diagram
6	0.41/3352	Overland Conveyors cable block diagram
7	0.41/3091	MV cable block diagram
8	0.41/141	Station Supplies
9	19.41/21802	11 kV Station board 2 panel key cabling diagram
10	26.41/39878	11 kV Sewage plant boards
11	0.41/13326	11 kV Compound board 1 key cabling diagram
12	0.41/13402	11 kV Compound board 2 key cabling diagram
	0.41/3062	DC station diagram functional group 5
	0.41/39989	11 ASQ and Sewage plant boards DC station diagram
	19.41/21776	11kV STN BRD 1&3 PANEL ARRANGEMENT
	26.41/37564	MV switchgear cable lugs standard dimensions

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX B: EQUIPMENT LIST TECHNICAL PARAMETERS



Technical parameters
for all Switchgear.xls

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX C: SWITCHGEAR SCHEDULES



240-77300784.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX D: MV SWITCHGEAR SCHEDULE A&B



240-93576770technical
schedule AB.xls



RMUtechscheduleAn
B.pdf



RMUtechscheduleAn
B1.pdf

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX E: PROTECTION SCHEME TECHNICAL SCHEDULE A&B



Protection Technical
Schedules A & B.xls

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX F: CONTROL AND INSTRUMENTATION SIGNALS



Control and
instrumentation signals

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX G: ELECTRICAL CABLE SCHEDULE



ELECTRICAL Cable
Schedule.xlsm

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX H: DC EQUIPMENT LIST



batterycharger
equipment list.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX I: SUBSTATION LAYOUTS

Item	Document No.	Document Description
1	19.41/21797	Station board 2&4 switchgear panel arrangement
2	41/39996 sht 4	coal conveyor board 3&6 substaion layout
3	0.41/39996 sht 3	coal conveyor board 4&5 substaion layout
	0.41/39996 sht 5	coal conveyor board 7&12 substaion layout
4	0.41/39996 sht 7	coal conveyor board 10&9 substaion layout
5	0.41/39996 sht 8	coal conveyor board 13 substaion layout
6	0.41/39996 sht 10	ASQ board 1&2 substation layout
7	0.41/39996 sht 9	Sewage plant board substation layout
8	0.41/265	Arnot station area road layout
9	26.41/45	Arnot power station cable route marker details

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

APPENDIX J: VDDS & LOSS



Copy of ARNOT
VDSS SWITCHGEAR F



LOSS.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.