

	DETAILED SPECIFICATION (ELECTRICAL)	Template Identifier	240-129665388	Rev	2
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ASSET DESIGN					
3.1. DETAILED SPECIFICATION (POWER PLANT ELECTRICAL)					
Project Name:	MAKHATHINI 132/22-kV SUBSTATION: 2 x 3MVA _r 22kV CAPACITOR BANK C-TYPE FILTER ESTABLISH				
Project No.'s:	ID	ET-STM-1712-4442-01	WBS	CDE05363	
Document Identifier:	PW	ER00024-00-P05#3.1-00	Rev	0	
Division & Operating Unit:	Distribution – Kwa-Zulu Natal Operating Unit				
Section:	Asset Creation – Network Engineering and Design				
Department:	Asset Design				
Project Category:	Strengthening				
Project Lifecycle Phase:	Detail Design				

Compiled and Checked by:		Authorised by:	
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Designation:	Senior Design Engineer	Designation:	Design Manager
Date:	21 November 2022	Date:	21 November 2022
Signature:		Signature	

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

TABLE OF CONTENTS

TABLE OF CONTENTS	ii
FOREWORD	iii
TEMPLATE REVISION HISTORY	iii
DOCUMENT REVISION HISTORY	iii
1. INTRODUCTION	4
2. QUALITY CONTROL	4
3. DELIVERY, STORAGE AND INSTALLATION OF ELECTRICAL EQUIPMENT	5
3.1. Delivery of Equipment	5
3.2. Storage of Equipment	5
3.3. Installation of Equipment.....	5
3.4. "As Built" Information.....	7
4. SUBSTATION EARTHING.....	7
4.1. Main Substation Earthmat.....	7
4.2. Earthing of Steelwork and Equipment.....	8
4.3. Earthing of Transformers	8
4.4. Earthing of Terminal Structures	8
4.5. Earthing of Ancillary Equipment	8
4.6. Earthing of Control Building & Panels.....	9
4.7. Earthing of Gates and Fences	9
4.8. Earthing of Low Voltage (<1,000V) Cables.....	10
5. STEELWORK (CIVIL)	10
6. NEW POWER PLANT EQUIPMENT	11
7. OVERHEAD CONDUCTORS.....	11
8. CABLE TRENCHES AND CABLE ROUTES	12
9. CABLING AND TERMINATIONS	12
9.1. LV Cabling.....	12
9.2. MV Cabling.....	12
10. YARD STONE	13
11. FENCING	13
12. YARD LIGHTING, PLUG BOXES AND JUNCTION BOXES	13
12.1. Yard Lighting	13
12.2. Yard Plugs and Junction Boxes	14
13. SUBSTATION LABELS.....	14
14. SWITCH / CONTROL ROOM	14
15. POWER PLANT COMMISSIONING.....	15
ANNEXURE 1: SCHEDULE OF ELECTRICAL HOLD POINTS.....	16

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

FOREWORD

This document is the Detailed Specification for the **Makhathini 22-kV Filter Capacitor Bank Bay Establish** and covers the Electrical (Power Plant) specifications. This document is to be read in conjunction with the General Specification for the Civil and Electrical works.

TEMPLATE REVISION HISTORY

REV	Date	Compiler	Comment
0	2014	J. K. Raghubir	Old document re-worded. New ISO template used.
1	January 2015	J. K. Raghubir R.H. Krusekopf	General Revision
2	October 2019	J. K. Raghubir	Authorisation & Review Dates changed

DOCUMENT REVISION HISTORY

REV	Date	Compiler	Comment

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

1. INTRODUCTION

This project shall conform in all instances to the Occupational Health and Safety Act and Regulations, No. 85 of 1993, and any amendments thereto, including the Safety Specification referred to in Regulation 4 of these statutory requirements. The contractor shall provide a Health and Safety Plan in compliance with the Occupational Health and Safety Act and Regulations, No. 85 of 1993, based upon but not limited to the Health & Safety Specification included in this package.

The scope of work under this project shall be carried out in full accordance with this detailed specification, all Standard Drawings (refer addendum 3.5), Project Specific Drawings (refer addendum 3.6) and the Standards and Specifications Index (refer addendum 3.7) included in the project package. These specifications shall be read in conjunction with the General Specifications and Works Information for the Civil and Electrical Works and the Detailed Specification for the Civil Works.

2. QUALITY CONTROL

- 2.1.1. The latest revision of Eskom's *"Quality Checking of Distribution Substation Construction before handing over for Commercial Operation"* document must be completed in full by the relevant parties including the Clerk of Works and Contractor. This document must be returned to the Project Manager and filed as "as - built" documentation.
- 2.1.2. Compliance by the contractor with the "Schedule of Hold Points" included in Annexure 1 of this Detailed Specification shall be mandatory and enforced accordingly by the Clerk of Works. All project time schedules shall include these hold points for quality inspection by the Design Engineer and/or Clerk of Works. Hold Points have been labelled with a prefix "E" indicating Electrical and "C" indicating Civil.

❖ **Hold Point E1:** Refer to schedule of hold points in Annexure A.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

3. DELIVERY, STORAGE AND INSTALLATION OF ELECTRICAL EQUIPMENT

3.1. Delivery of Equipment

- 3.1.1. The contractor shall ensure that all equipment to site is received by a competent person (Materials Receiving Clerk / Store man) who will ensure that all material is in good condition when received.
- 3.1.2. A complete inventory of all material is to be kept and must be available for inspection at any time by the Project Manager. Equipment damaged in transit or during construction, must be replaced / repaired at the Design Engineers / Clerk of Work's discretion and any costs incurred shall be for the contractor's account.

3.2. Storage of Equipment

- 3.2.1. All equipment stored on site must be stored in accordance with the manufacturer's and Eskom specifications and secured against vandalism and theft.
- 3.2.2. All indoor equipment must be stored under cover and kept dry.
- 3.2.3. Outdoor equipment must be stored off the ground and kept out of water and mud. Breakers must have their heaters connected.
- 3.2.4. Long rod insulators must be hung to avoid damage.
- 3.2.5. Transformer and NECRT's must have their breathers fitted and filled with fresh silica gel or other approved product.
- 3.2.6. Transformer oil must be stored in a temporary bunded area to avoid any oil spillage.

3.3. Installation of Equipment

- 3.3.1. All equipment detailed in the design of this project is to be installed and connected by the contractor and shall be done in accordance with the relevant Eskom and/or manufacturer's specifications.
- 3.3.2. Equipment shall be installed in position in accordance with the applicable detailed design drawings, specifications and sound engineering practices.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

- 3.3.3. Initial mechanical adjustments of the isolators and preliminary testing of cabling to prove correct installation shall be undertaken by the contractor. Final mechanical adjustment of all isolators will be done by Eskom's PPM section.
- 3.3.4. Equipment shall be erected vertically into the correct position, central to the setting out line established for the specific bay and referenced to the official setting out lines for the substation indicated on the relevant drawing. Levels for applicable structures shall also be checked prior to any equipment being installed.
- 3.3.5. 132kV breakers shall only be erected by Eskom PPM or by the supplier. The contractor is not permitted to erect these breakers.
- 3.3.6. Any exposed LV cabling connected to equipment shall be secured in position on galvanized steel cable tray correctly supported.
- 3.3.7. Table 1 contains the Minimum Safety Electrical and Working Clearances that shall be adhered to for all installed equipment and the associated conductors.
- 3.3.8. Extreme care must be taken and enforced when storing, handling, erecting or installing equipment to ensure compliance with manufacturer's specifications.
- 3.3.9. Final testing and commissioning of the installed electrical equipment shall be performed by the manufacturer, Eskom or an Eskom appointed contractor.

Table 1: Minimum Electrical and Working Clearances

System Voltage (Un) kV	Min. Electrical Clearances (mm)		Min. Working Clearances (m)	
	Ph - E	Ph - Ph	Vertical	Horizontal
6.6	150	200	2.6	1.2
11	200	270	2.7	1.3
22	320	430	2.8	1.4
33	430	580	2.9	1.5
88	840	1150	3.3	1.9
88*	1000*	1350*	3.5*	2.1*
132	1200	1650	3.7	2.3

* Indicates values for full insulation at 88kV and are only to be used if the system is not effectively earthed

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

3.4. “As Built” Information

- 3.4.1. The “as-built” package shall be submitted to the Project Manager in order for handover of the substation to be finalized and shall include all primary and control plant marked up drawings; all commissioning test records for both primary and control plant equipment and earthmat resistance and continuity readings as detailed in the Substation Quality and Handover document.

4. SUBSTATION EARTHING

4.1. Main Substation Earthmat

- 4.1.1. Depending on the tender requirements for the project, the installation of the main substation earthmat may be completed by either the civil or electrical contractor.
- 4.1.2. All information regarding the earthmat design is to be treated as preliminary. Earth resistivity measurements will be taken again after clearance and preparation of the substation terrace and the detail earthmat design may be revised accordingly.
- 4.1.3. The contractor is required to test the earthing installation on completion for electrical continuity and general resistance to earth. The Clerk of Works shall witness these tests.
- 4.1.4. The *extension* to the main substation earth mat shall be laid **one meter (1m)** below finished ground level with **10mm diameter hard drawn copper rod** installed concurrently with the earth works to avoid disturbance of the final formed and compacted terrace.
- 4.1.5. All joints, crossings and connections to the earthmat conductors shall be undertaken using the **silbralloy brazing** method for proper electrical connections. Sample joints shall be approved by the Clerk of Works prior to any brazing on site.
- 4.1.6. The earthmat shall extend **1m beyond the security fence**. The corners of the most outer earth rod forming the perimeter of the earthmat must be formed with slow bends to avoid high voltage gradients. The earthmat shall extend further at gates to cover the opening gate leaves.

❖ **Hold Points E2 and E3:** Refer to schedule of hold points in Annexure A.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

4.2. Earthing of Steelwork and Equipment

- 4.2.1. All new yard equipment shall be **earthed through their steel supports**, which is connected to the earthmat through the holding down bolts using **50mm x 3mm flat copper bar**. Where existing foundations are retained, the equipment steelwork may be exothermically welded to the earthmat by accredited installers at the engineer's direction.
- 4.2.2. All **foundation bolts** in each foundation must be **bonded together inside the foundation** using the 50 x 3mm flat copper bar as per the earthing standard.
- 4.2.3. All equipment support foundations shall have at least **two earth tails** connected to the foundation bolts at diametrically opposite points and connected to different conductors of the earth mat.
- 4.2.4. Foundations for steel columns shall have the earth tail(s) connected between the corresponding foundation bolt set and the main earth mat. For 132kV steel columns, the copper earth tail is bolted to the flat steel coupling plate of a specific pair of foundation bolts. Depending on the fault level of the substation, more than one earth connection may be required.
- 4.2.5. NECRT's are effectively earthed through the foundation bolts as for other equipment.

4.3. Earthing of Transformers

- 4.3.1. Existing - N/A

4.4. Earthing of Terminal Structures

- 4.4.1. Existing - N/A

4.5. Earthing of Ancillary Equipment

- 4.5.1. All ancillary equipment (junction boxes, etc.) shall be earthed through the steel support by means of a 50 x 3mm flat copper bar between the earth stud of the equipment and the equipment steelwork.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

4.6. Earthing of Control Building & Panels

- 4.6.1. The building earth shall comprise a **50mm x 3mm flat copper bar**, fixed to the cable racking and be connected to the main substation earth mat at two points.
- 4.6.2. Where the earth bar is fixed to cable racking, it shall be clamped with splice clamps at 1m intervals.
- 4.6.3. The reinforcing mesh in the switchroom and/or control room floor slab/s must be bonded to the building earth at one point only.
- 4.6.4. Each floor standing control panel shall be bonded to this earth bar by means of a **70mm² green/yellow insulated, stranded flexible copper conductor**. These tails shall be lugged and bolted to the 50 x 3mm earth bar and lugged and bolted to the panel earth bar via an M12 brass set screw.
- 4.6.5. The distribution boards (AC and DC) shall be bonded to the main earth conductor installed in the control room, by means of a 50 x 3 flat copper bar.
- 4.6.6. The steel doors in the control room and switch rooms must be bonded to the earthmat. Suitable lugging points must be provided in the door frames.
- 4.6.7. The indoor switchgear shall be connected to the 50 x 3mm copper earth bar in the MV cable trench at either end of the switchboard using 50 x 3mm copper bar.

4.7. Earthing of Gates and Fences

- 4.7.1. All gate posts and corner posts must be bonded to the earthmat using **50 x 3mm copper bar tails**.
- 4.7.2. The fence must be bonded to the earthmat at a minimum of **20m** intervals.
- 4.7.3. Each gate leaf must be bonded to the gate post by a 70mm² UV stabilized sheathed, stranded flexible copper conductor that is suitably lugged and bolted at each end.
- 4.7.4. The earthmat must be extended at gate openings to protect personnel from dangerous touch potentials when opening/closing the gates.
- 4.7.5. Final connections to the fence must be done within the 100mm stone layer to minimise visibility.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

4.8. Earthing of Low Voltage (<1,000V) Cables

- 4.8.1. The armoring must be earthed at both ends of LV cables through the cable gland where the gland plate is conductive or by adding an earth ring where the gland plate is non-conductive. Where necessary, the earth rings and gland plate must be bonded to the provided earth bar/stud.
- 4.8.2. All spare cable cores must be earthed at the panel end by lugging the cores and bolting them together per cable. A single green earth core must connect these cores to the earth bar/stud. The green earth core must be numbered (using ferrules) as per the cable number.
- 4.8.3. Only brass or stainless steel bolts, nuts and washers may be used for these electrical connections. Galvanized or electroplated bolts are not acceptable.

4.9. Earthing of Medium Voltage (>1,000kV) Cables

- 4.9.1. N/A

4.10. Earthing of Mobile Substation Bay

- 4.10.1. N/A

❖ **Hold Point E4:** Refer to schedule of hold points in Annexure A.

5. STEELWORK (CIVIL)

- 5.1.1. The quality control inspections to be undertaken on all fabricated steelwork must comply with 240-94743192 Standard for Fabrication Steelwork in every respect. The main focus areas included in this process being, prior to manufacture, galvanizing and final dispatch.
- 5.1.2. No welding other than that specified on the drawing, or cutting of steelwork after galvanizing, shall be permitted.
- 5.1.3. All equipment supports and sub-station steelwork must be manufactured and finished in accordance with the relevant drawings. All galvanizing shall be to SANS 121 and delivered to site complete and bundled.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

6. NEW POWER PLANT EQUIPMENT

- 6.1.1. All power plant equipment shall be supplied and installed with strict adherence to the mandatory safety clearances (electrical, working, etc.) specified in the latest edition of the OH&S Act and in accordance with the relevant Eskom specifications and drawings.
- 6.1.2. All electrical power plant equipment is to be installed in accordance with the relevant Eskom drawings provided with the design package. Table 1 summarizes all new electrical equipment to be installed.
- 6.1.3. All new equipment will be supplied and installed as per the Bills of Materials and standard Eskom specifications in section 3.7 of the package.

❖ **Hold Points E5 and E6:** Refer to schedule of hold points in Annexure A.

7. OVERHEAD CONDUCTORS

- 7.1.1. The stringing of jumpers and attachment of all conductors to equipment shall be undertaken with strict adherence to the mandatory safety clearances (electrical, working, etc.) specified in the latest edition of the OH&S Act and in accordance with the relevant Eskom specifications and drawings.
- 7.1.2. A competent person shall be responsible for installation and fastening of all conductor clamps in accordance with the manufacturer's specifications and torque values. Proof of this application is to be submitted to the Clerk of Works.
- 7.1.3. Once each clamp is tightened to the correct torque value, proof of this shall be indicated via a "dab" of suitably colored enamel paint being applied to each applicable bolt head.
- 7.1.4. For copper to aluminum connections, the correct bi-metallic components shall be used.
- 7.1.5. Reference must be made to the "Sags and Tension Tables" for the correct stringing values of all busbars and stringers installed at the substation.
- 7.1.6. The contractor responsible for construction the HV line shall terminate the line and associated shield wire(s) onto the relevant support steelwork in the substation.

❖ **Hold Points E7:** Refer to schedule of hold points in Annexure A.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

8. CABLE TRENCHES AND CABLE ROUTES

- 8.1.1. Cables laid directly in the ground shall be buried at the following levels below ground

Low voltage cables ($\leq 1,000\text{V}$)	500mm
Medium voltage cables (11kV – 33kV)	1000mm

- 8.1.2. All new cables shall be installed in the designated cables routes according to the cable routes drawing in a neat and orderly manner.
- 8.1.3. Concrete cable route markers are to be installed on the surface of the yard and/or ground for all MV cable route direction changes and at intervals not exceeding 20m for straight runs.
- 8.1.4. All boulders, sharp objects and construction debris likely to cause damage to cables shall be removed from trenches and backfill material before the trenches are closed.
- 8.1.5. The backfill material shall be properly compacted before yard stone is laid. The 100mm thick layer of 26mm grade granite yard stone shall be replaced once the backfill material has been used to close the trenches.
- 8.1.6. Danger tape shall be laid in all cable trenches 200mm below final ground level.
- 8.1.7. Suitable concrete pipes or ducts shall be installed for MV cable road crossings as detailed in the project drawings. Suitable uPVC (160mm dia.) ducts shall be installed under roads for all control cables

9. CABLING AND TERMINATIONS

9.1. LV Cabling

- 9.1.1. All low voltage armored cables shall be terminated with mechanical glands fitted with earth rings and shrouds. These cables shall be identified at both ends by punched or engraved brass tags attached to the cable with galvanized wire.
- 9.1.2. The cores shall be correctly identified with alphanumeric ferrules and terminated with the correct size of hook blade connectors.

9.2. MV Cabling

- 9.2.1. **N/A**

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

10. YARD STONE

- 10.1.1. The substation yard shall be covered with a **minimum of a 100mm thick layer of 26mm grade** granite, tillite or dolerite stone chips.
- 10.1.2. The stone chips must be derived from the crushing of solid, un-weathered quarried rock. The material must be free of dust and other deleterious substances.
- 10.1.3. The material must comply with the SANS 1083:2013 Table 2 – Course aggregate for concrete specification.
- 10.1.4. The stone shall be retained 1.2m beyond the substation fence by pre-cast concrete kerbing.

11. FENCING

- 11.1.1. The substation security fence shall be of the steel palisade type and the capacitor yard wire mesh type and manufactured and installed in accordance with the Eskom approved drawings.
- 11.1.2. Any temporary fences that may be required during the construction phase of the project shall be supplied and erected by the contractor at their expense.
- 11.1.3. All temporary fences and gates shall be bonded to the main substation earth mat where risk of electric shock is present.

12. YARD LIGHTING, PLUG BOXES AND JUNCTION BOXES

12.1. Yard Lighting

- 12.1.1. Combined operational and security lighting shall be provided by 400W high pressure sodium floodlights positioned according to the relevant drawings within the cap bank yard and mounted on the existing columns.
- 12.1.2. The light circuits shall be protected via suitably rated MCB's and associated contactors, located in the AC distribution board.
- 12.1.3. Identified security lights shall be switched by a contactor and controlled by a "Daylight" photocell. Additional operational lighting shall be switched by a separate contactor and controlled by a wall mounted switch inside the control room.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

12.1.4. Each yard lamp shall be isolated locally via a suitably rated LV single-pole MCB's mounted in a lighting junction box at the base of the relevant column or mast.

12.1.5. The final connection between the lighting junction box and the flood light shall be 2.5mm² 2-core + earth "Suffix" or equal, color black.

12.2. Yard Plugs and Junction Boxes

12.2.1. N/A - Existing

13. SUBSTATION LABELS

13.1.1. All substation labels and their respective brackets shall be supplied by Eskom and installed by the contractor according to the station electric diagram and label schedule.

13.1.2. Phase labels shall be fitted to all busbars, stringers, bus-couplers and feeder bays.

13.1.3. Reference must be made to the relevant project drawing to obtain the correct phase label convention.

13.1.4. Equipment labels shall be fitted to all applicable operating equipment, junction boxes, control boxes, etc., in the substation yard and to all applicable equipment installed in battery, control and switch rooms.

13.1.5. OHS Act notices (safety and warning) are to be fitted where appropriate. Reference must be made to the "Label Schedule" included in the Project Package.

❖ **Hold Point E8:** Refer to schedule of hold points in Annexure A.

14. SWITCH / CONTROL ROOM

14.1. Switchroom Cabling and Panel Arrangement

14.1.1. Cable entry from the substation yard into the control building shall be provided via suitable ducts as detailed on the drawings.

14.1.2. The control room cables shall be installed in the wire mesh cable racking (minimum 600mm wide) fixed to the walls or suspended from the roof for top entry into all

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

panels in a neat and orderly fashion. The wire mesh cable tray is to be supplied and installed by the building contractor.

- 14.1.3. The flat copper earth bar shall be secured to the front of the cable rack via suitable spline clamps as specified by the cable rack supplier.
- 14.1.4. All armored cables shall be terminated by means of mechanical glands, fitted complete with earth rings and shrouds.
- 14.1.5. The cores shall be identified and terminated with approved spade and pin type connectors, as indicated on the relevant drawings.
- 14.1.6. All cables shall be identified at both ends by punched or engraved brass tags attached to the cable with galvanized wire. These tags are supplied by Eskom.

15. POWER PLANT COMMISSIONING

- 15.1 Commissioning of all primary plant equipment shall be carried out in accordance with the relevant Eskom specifications.
- 15.2 The results of all primary plant commissioning shall be documented on the relevant commissioning sheets and be submitted to the Eskom representative for acceptance.
- 15.3. Copies of these commissioning sheets are required by Control prior to energising of the equipment.

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
	Document Identifier	ER00024-00-P05#3.1-00	Rev	0

ANNEXURE 1: SCHEDULE OF ELECTRICAL HOLD POINTS				
Hold Point No.	Section Ref. No.	Hold Point Detail	Clerk of Works Signature & Date	Contractor Signature & Date
NOTE	All	General: It is essential that all “hold points” are observed as such by the contractor/s and no further work is to continue on each particular stage, until this has been inspected and approved by the Design Engineer and/or Clerk of Works. An agreed time must be established between the contractor and the Design Engineer and Clerk of Works for suitable notice to inspect. Failure to comply will put the contractor/s at risk.		
E1	2	Quality Control System: The contractor shall implement a quality check system throughout the duration of this project. The contractor shall provide regular feedback on all aspects of quality control on the site, which shall constitute a pre-requisite to the final hand-over / take-over stage of the project.		
E2	4.1	Sample Welding Joints of Earthmat: A sample welding of the earthmat joint shall be performed by the contractor and witnessed by the clerk of works. The contractor shall commence with the actual project related work upon acceptance of the sample joint.		
E3	4.1	Main Substation Earthmat Installation and Testing: Once all jointing is completed and before the earth mat is buried, the Design Engineer and/or Clerk of Works are to be notified in advance so that an inspection		

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3.1. Detailed Specification (Electrical): Makhathini 22-kV Cap Bank Establish	Template Identifier	240-129665388	Rev	2
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		of the earth mat and connections can be undertaken. The contractor shall complete the earth mat resistance measurement and continuity tests. The Design Engineer must ensure the results are acceptable for the conditions. The earthmat can only be buried upon acceptance of the earthmat jointing and testing.		
E4	4	Substation Equipment Continuity Tests: Once all equipment is installed, earth continuity tests between equipment steelwork and the main earthmat shall be conducted prior to energizing the substation.		
E5	6	Installation and cold commissioning of all primary plant equipment: The installation and cold commissioning of the all outdoor primary plant equipment shall be considered a critical hold point. The Clerk of Works shall witness the installation and cold commission of the equipment by suppliers and/or relevant Eskom Departments. All test documents shall be included in the "as-built package" or provided to the Design Engineer.		
E7	7	Overhead Conductors and Stringing: Before any compression joints are applied, the compression joint tools shall be checked and approved by the Clerk of Works. A sample compression joint shall also be performed by the contractor and witnessed by the clerk of Works prior to commencement of the actual project related work to ensure final compliance with manufacturer's specifications.		
E8	13	Substation Labels: The contractor is to ensure that the labels received on site comply with the operating diagram and label schedule included in the Project Package prior to energization of the substation.		

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