ASSET DESIGN
1.1. GENERAL SPECIFICATIONS AND WORKS INFORMATION

Project Name:	**Mashaqiya Solar project- Nkandla**			
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Department:	**Asset Design (Power Plant, Civil, Control Plant)**			
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FOREWORD

This document is the General Specification and Works Information for the **Mashaqiya Solar project- Nkandla** and Electrical requirements. It also covers the Quality Control and Quality Assurance requirements of the project. It contains information on the scope of works and staging of the project for ease of construction. This document is to be read in conjunction with the Detailed Specification for the Electrical works.

SECTION A: GENERAL SPECIFICATIONS AND WORKS INFORMATION

1. EXECUTIVE SUMMARY

(Section C3.1 of the NEC3 Engineering and Construction Short Contract)

1.1. Background to the Project

Eskom Distribution is preparing for a modernised and flexible electricity distribution industry that supports future energy markets, customer accessibility, and Eskom's Just Energy Transition objectives. The future distribution grid is expected to enable bi-directional power flow, integration of Distributed Energy Resources, battery storage, microgrids, smart grids, smart homes, electric vehicles, and other emerging technologies.

Within this strategic context, the Central Eastern Cluster is supporting the implementation of new energy technologies and alternative electrification solutions. Mashaqiya Village, located approximately 20 km south of Melmoth in KwaZulu-Natal, consists of 59 households and Maqhashiya Primary School. Due to the rural location and challenging terrain conditions, conventional grid extension is not considered practical. The project therefore provides an opportunity to apply off-grid Solar Home Systems (SHSs) as a suitable electrification solution aligned with Eskom Distribution's future grid and rural electrification strategy.

1.2. Interface with associated projects

The following projects are associated with the works as described:

a) No associates

1.3. Objectives of the works

The objective of the works is to provide a reliable, sustainable, and cost-effective electrification solution for 59 households and Maqhashiya Primary School through the implementation of off-grid SHS, supported by a practical, safe, and SANS 62305-compliant earthing and lightning protection system to ensure personnel safety, equipment protection, and continuity of electricity supply.

1.4. Site Selection and Dimensions

Mashaqiya Village, located approximately 20 km south of Melmoth in KwaZulu-Natal, was selected as the case study due to the impracticality of conventional grid extension and the need for rural electrification through off-grid SHSs. The PV carport structure used for the design

assessment has dimensions **of 6.634 m × 4.000 m with a 20°** tilt angle, solar PV panels shall face north, and these dimensions were used in the earthing and lightning protection design calculations.

SHS Footprint

Below are the parameter of the complete Solar Home System:

Parameter	Value
Length	8.634 m
Width	4.861 m
SHS Footprint Area	42 m²
PV Tilt Angle	20°

2. SITE INFORMATION

(Section C4.1 of the NEC3 Engineering and Construction Short Contract)

2.1. Description of the Site and Access

Mashaqiya Village is located approximately 20 km south of Melmoth in KwaZulu-Natal. The area is predominantly rural, with dispersed homesteads situated across uneven terrain, including rocky and elevated areas. Access to the project area is primarily via local gravel roads. In some sections of the village, access to households requires crossing a river and, in some section, there is a pedestrian bridge.

2.2. Existing infrastructure (buildings, structures, plant & machinery) on the site

The site consists primarily of residential dwellings, Maqhashiya Primary School, local access roads, and a pedestrian bridge providing access across the river to some households. The proposed SHSs will be installed within individual household yards. During the site visit, it was observed that some households have existing lightning conductors installed. No major industrial plant, machinery, or significant electrical infrastructure currently exists within the project area.

3. DESCRIPTION OF THE WORKS

(Section C4.1 of the NEC3 Engineering and Construction Short Contract)

3.1. Introduction

This project shall be carried out in full accordance with this detailed scope of work, all other technical specifications referred to, and the relevant drawings provided by Eskom (refer attachments). 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.

3.2. Works Information: List of Drawings

3.2.1. Standard Drawings

Refer to the civil standard drawings and index and the standard electrical power plant equipment drawings and index.

3.2.2. Project Specific Drawings

Project specific drawings will further reference standard and detail drawings. Some drawings may contain both Works Information and Site Information.

3.3. Works Information: Standards and Specifications

All Eskom Standards and Specifications are typically revised every 5 years and available on request.

3.4. Scope of Work Construction Program and Constraints

The following stages are recommended as part of the constructability plan. Certain stages can be completed in parallel provided that adequate resources are provided by the Project Manager and/or Contractor. Any deviations and/or changes (for practical reasons or otherwise) must be approved by the Design Engineer/s and/or Section/Zone Manager prior to construction. It must be noted that the staging recommended below may have practical implications and thus needs to be reviewed prior to construction. Where outages are required, this is indicated by an asterisk (*).

The following is applicable to all stages of the construction program:

a) Access to site is to be issued by the Project Manager to the contractor.
b) All required permits are to be issued, and risk assessments completed.
c) The contractor is to comply with all safety standards and procedures.
d) Reference is to be made to the applicable drawings included in the design package.

Assumptions and Constraints:

a) The access will be gained from the gate.

3.4.1. Scope of Work and Proposed Construction Sequence

3.4.1.1. Primary Plant (Electrical)

The works include the supply, installation, testing, and commissioning of the earthing and lightning protection systems for 59 households and one primary school in Mashaqiya Village. The scope of work includes, but is not limited to, the following:

a) Supply and install a Class III Lightning Protection System, comprising 4 × 1 m high aluminium air termination rods mounted on the PV carport structure edges.

b) Supply and install a 2 × 3 m long, 16 mm diameter copper-clad steel earth rods according to the design drawings and interconnected using 10mm diameter round copper conductor.
c) Supply and install 10mm diameter round copper conductor for equipotential bonding of the PV carport structure, equipment enclosure support structure, and associated metallic components to the common earthing system.
d) Provide earthing and equipotential bonding connections for the AC and DC Surge Protection Devices (SPDs) to ensure integration with the common earthing and lightning protection system.
e) No earthing or bonding is required for the pole-top box structure, as it is a non-metallic component and does not introduce exposed conductive parts.
f) Perform testing and commissioning of the earthing and lightning protection system, including earth continuity testing, bonding verification, earth resistance measurements, and verification of overall system functionality. One SHS shall be installed and tested as a pilot installation. Additional earth electrodes shall be installed where necessary to achieve compliance before proceeding with the remaining installations.

3.4.1.2. Proposed Construction Sequence

a) Site clearing and removal of topsoil.
b) Civil bulk earthworks, including intermediate excavation, removal of boulders from site, and backfilling with approved material.
c) Setting out of the PV carport positions and earthing system locations.
d) Excavation and installation of the 50 × 3.15 mm flat copper conductor within the foundations for equipotential bonding of the steel support structure and connection to the common earthing system.
e) Establishment and casting of the carport foundations and enclosure support structure.
f) Installation of the earth rods and associated inspection pits.
g) Installation of the 10mm diameter round copper conductor for interconnection of earth rods and connection to the common earthing network.
h) Erection of the galvanised steel PV carport structure.
i) Installation of equipment enclosure support structure.
j) Installation of the air termination rods on the PV carport structure.

k) Bonding of all four corners of the PV carport structure and equipment enclosure support structure to the main earthing system.

l) Provision of earthing and bonding connections for AC and DC Surge Protection Devices (SPDs).

m) The testing and commissioning of all installed equipment.

n) Rehabilitating of the site in accordance with the Environmental Management Plan.

3.4.2. Project Assumptions and Constraints

- As per scope of work
- The SHS installations will be constructed in accordance with the approved designs and applicable standards.
- The steel PV support structures will provide electrical continuity for use as natural down conductors.
- Site soil resistivity data is assumed to be representative of actual ground conditions.
- SPDs and associated equipment will be bonded to the common earthing system.
- The project is located in a remote rural area with challenging access, including households accessed via a pedestrian bridge and crossing the river.
- Rocky terrain, variable soil conditions, and high soil resistivity may affect earth electrode installation and achievable earth resistance values.
- Construction, maintenance, and equipment replacement activities may be constrained by site accessibility and terrain conditions.
- Final system performance will be confirmed through testing and commissioning after construction.
- CNC & other operational staff to be trained & familiarized.
- All construction work to be done under supervision & adherence to Eskom standards & policies.
- Quality control to be implemented by engineers & clerk of works.

SECTION C: DETAILED ELECTRICAL SPECIFICATION

4. 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, Project Specific Drawings, and the Standards and Specifications Index 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.

5. QUALITY CONTROL

5.1.1. The relevant sections of Eskom's *"Quality Checking of Distribution Substation Construction before handing over for Commercial Operation"* document no. 240-87605434, 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.

5.1.2. 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.

6. DELIVERY, STORAGE, AND INSTALLATION OF ELECTRICAL EQUIPMENT

6.1. Delivery of Equipment

6.1.1. 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.

6.1.2. 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.

6.2. Storage of Equipment

6.2.1. All equipment stored on site must be stored in accordance with the manufacturers and Eskom specifications and secured against vandalism and theft.

6.2.2. All indoor equipment must be stored under cover and kept dry.

6.2.3. Outdoor equipment must be stored off the ground and kept out of water and mud.

6.3. Installation of Equipment

6.3.1. 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.

6.3.2. Equipment shall be installed in position in accordance with the applicable detailed design drawings, specifications, and sound engineering practices.

6.3.3. Preliminary testing of cables to prove correct installation shall be undertaken by the contractor.

6.3.4. 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 site indicated on the relevant drawing. Levels for applicable structures shall also be checked prior to any equipment being installed.

6.3.5. Any exposed LV cabling connected to equipment shall be secured in position on galvanized steel cable tray correctly supported.

6.3.6. Table 1 contains the Minimum Safety Electrical and Working Clearances that shall be adhered to for all installed equipment and the associated conductors.

6.3.7. Extreme care must be taken and enforced when storing, handling, erecting or installing equipment to ensure compliance with manufacturer's specifications.

6.3.8. Final testing and commissioning of the installed electrical equipment shall be performed by the manufacturer, Eskom or an Eskom appointed contractor.

6.4. "As Built" Information

6.4.1. The "as-built" package shall be submitted to the Project Manager in order for handover of the SHS 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; earth resistance and continuity readings as detailed in the Substation Quality and Handover document.

7. EARTHING

7.1. Main Earthing System

7.1.1. Depending on the tender requirements for the project, the installation of the earthing system may be completed by either the civil or electrical contractor.

7.1.2. The contractor is required to test the earthing installation on completion for electrical continuity and general resistance to earth. The CoW must witness these tests.

7.1.3. The earthing system shall comprise a Type A earth termination arrangement consisting **of 2 × 3 m long, 16 mm diameter** copper-clad steel earth rods interconnected using **10mm diameter round copper conductor**. The round copper conductor shall be installed at a depth of **0.6 m** below finished ground level and concurrently with the earthworks to minimize disturbance of the final formed and compacted terrace. The conductor shall also be embedded within the foundations and bonded to the steel support structure to provide equipotential bonding and connection to the common earthing system

7.1.4. All joints, crossings, and interconnections of the earthing system shall be completed using the **Silbralloy brazing** method to ensure permanent, low-resistance, and mechanically robust electrical connections. Sample joints shall be approved by the CoW prior to any brazing on site.

7.1.5. Joints between the round copper and copper-clad steel earth rods required to be done using **Exothermic welding**.

7.1.6. Refer to SANS 62305 Protection Against Lightning , 240-134369472, Substation Earth Grid Design Standard, and D-DT-5240 for the general earthing practices to be applied.

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

7.2. Earthing of Steelwork and Equipment

7.2.1. The carport shall be **earthed through their steel supports,** which is connected to the earth mat through the holding down bolts using **50mm x 3.15mm flat copper bar.**

7.2.2. All **foundation bolts** in each foundation must be **bonded together inside the foundation** using the 50 x 3.15mm flat copper bar as per the earthing standard.

7.3. Earthing of Enclosure

7.3.1. The enclosure earth shall comprise a copper earth busbar installed within the equipment enclosure and connected to the main earthing system. The earth busbar shall provide termination points for the inverter, battery system, AC and DC surge protection devices (SPDs), equipment enclosures, support structure, and all associated bonding conductors, thereby ensuring equipotential bonding throughout the installation. The earth busbar shall be securely mounted and provided with sufficient termination points to accommodate all required earth connections. The busbar shall be sized in accordance with the prospective earth fault current and

applicable standards. The installation shall comply with SANS 10142-1 and applicable Eskom standards.

7.3.2. The equipment enclosure supporting steel structure shall be bonded to the common earthing system to provide equipotential bonding and maintain a common earth reference potential for all exposed conductive parts.

***Note**: Prior to commencing the installation of all Solar Home Systems, the Contractor shall install and commission one complete Solar Home System as a pilot installation. The Contractor shall perform all specified inspections, tests and measurements, including earth resistance testing. Where the required earth resistance or other performance criteria are not achieved, additional earth electrodes or other corrective measures shall be implemented and the installation retested until compliance is demonstrated.*

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

7.4.1. 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.

7.4.2. 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.

7.4.3. Only brass or stainless-steel bolts, nuts and washers may be used for these electrical connections. Galvanized or electroplated bolts are not acceptable.

8. LABELS

8.1.1. Equipment labels shall be fitted with all applicable operating equipment, junction boxes, control boxes.

8.1.2. OHS Act notices (safety and warning) are to be installed where appropriate.

❖ **Hold Point E5:** Refer to schedule of hold points in Annexure A.

SECTION D: SHS STANDARD AND DESIGN DRAWINGS

D-DT	No.	SHT	REV	TITLE
D-DT	5240			Substation Earthing Drawings
KZN-EBC	2403-1190868	3 of 4	00	Earthing System Details
KZN-EBC	2403-1190868	4 of 4	00	Lightning Protection Layout

SECTION E: 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	7	**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	7	**Main SHS 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 of the earth mat and connections can be undertaken. The contractor shall complete the earth resistance measurement and continuity tests. The Design Engineer must ensure the results are acceptable for the conditions. The earthing system can only be buried upon acceptance of the earthmat jointing and testing.		
E4	**7**	**SHS Equipment Continuity Tests:** Once all equipment is installed, earth continuity tests between equipment steelwork and the main earthing system shall be conducted prior to energizing the substation.		
E5	**13**	**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.		