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3.2 PART II: STANDARDS, CODES AND REGULATIONS

3.2.1 GENERAL

For the purpose of this work, compliance with the all-relevant sections of the following standards shall be adhered to. Standard is viable only to the extent to which it is applicable.

3.2.2 STANDARDS, CODES AND GUIDELINES

The site information is described in table 1 below with the service conditions as follows:

Table C3.2.1: Site Information and contact details

STANDARD/CODE	DESCRIPTION / NAME
General	
	Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission system (TS) or the Distribution System (DS) in South Africa Version 2.8, July 2014
SANS 10142	The wiring of Premises – Part 1: Low voltage installation
PV Modules	
IEC 61215 Ed.2	Crystalline silicon terrestrial photovoltaic (PV) module - Design qualification and type approval
IEC 61730-1 Ed.1.2	Photovoltaic (PV) module Requirements for construction
IEC 61730 -2 Ed.1.0	Photovoltaic (PV) module Requirements for testing
IEC 61701 Ed. 2	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 62716 Ed. 1	Photovoltaic (PV) modules - Ammonia corrosion testing
IEC 60891:1987	Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic devices, Amendment 1 (1992) .
IEC 60904-1:1987	Photovoltaic devices – Part 1: Measurements of photovoltaic current voltage characteristics.
IEC 60904-2:1989	Photovoltaic devices – Part 2: Requirements for reference solar cells.
IEC 60904-6:1994	Photovoltaic devices – Part 6: Requirements for reference solar modules
IEC 60904-7:1998	Photovoltaic devices – Part 7: Computation of spectral mismatch error introduced in the testing of a photovoltaic device.
IEC 60904-9:1995	Photovoltaic devices – Part 9: Solar simulator performance requirements.
IEC 60904-10:1998	Photovoltaic devices measurements.
IEC 61853	Performance testing and energy rating of terrestrial photovoltaic (PV) modules
IEC 60068-2-78:2001	Environmental testing – Part 2-78: Tests – Test Cab: Damp heat steady state
IEC 60068-2-21:1999	Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices

Inverters	
IEC 62093 Ed. 1.0	Balance-of-system components for photovoltaic systems - Design qualification natural environments

IEC 62109-1 Ed 1.0	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
IEC 62109-2 Ed 2.0	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
IEC 62116 Ed 2.0	Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures.
IEC 60730-1 Ed.5	Automatic electrical controls - Part 1: General requirements.
NRS 097-2-1 Ed.1	Grid Interconnection of Embedded Generation Part 2: Small- scale embedded generation.
IEC 61683	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IEC 61000 - 6 / 3	Electromagnetic compatibility (EMC)
IEC 61000-6-3/4	EMC Emission
IEC 61000-6-1/2	EMC Immunity
IEC 61727 Ed.2	Photovoltaic (PV) systems - Characteristics of the utility interface
IEC 62103	Electronic equipment for use in power installations

Electrical Cabling	
	Requirements for cables for use in photovoltaic systems
SANS 1507 Part 1	General - Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 1507 Part 2	Wiring Cables - Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 1507 Part 3	PVC Distribution cables - Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 1507 Part 4	XLPE Distribution cables – Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3300 V)
SANS 1507 Part 5	Halogen-free Distribution Cables - Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 1507 Part 6	Service cables - Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 10198:2004 Parts 1-14	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 1 to 14
SANS 1213	Mechanical Cable Glands
NRS 074-1/2	Low Voltage cables systems

Earthing, Lightning & Surge Protection	
IEC 60364-4-41	Low-voltage plants installation. Part 4-41 - Protection for safety – protection against shock
SANS 10313	Protection against lightning
SANS 62305	Earthing and Lightning Protection
SANS 10292:2001	Earthing of low-voltage (LV) distribution systems
SANS 1063:1998	Earth rods and coupling
SANS 10199	The design and installation of earth electrodes
IEEE 80	Earthing

IEEE 665:1995	Guide for Generating Station Grounding
SANS 61312-3:2006/IEC TS 61312-3:2000	Protection against lightning electromagnetic impulse Part 3: Requirements of surge protective devices (SPDs)
SANS 62305-1 to 4 /IEC 62305-1 to 4	Protection against lightning - Parts 1 to 4
SANS 10313:2008	Protection against lightning - Physical damage to structures and life hazard
SANS 10200:1985	
NRS 039	Surge arresters for use in distribution systems
IEC 61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's)
SANS 61024	Protection of structures against lightning

Metering and Measurements	
IEC 62053	Electricity metering equipment (A.C.) – particular requirements
IEC 60051-1	Direct acting indicating analogue electrical measuring instruments and their accessories definitions and general requirements common to all parts
IEC 61036	Alternating current static watt-hour meters for active energy
NRS 057/ SANS 474	Code of practice for electricity metering
NRS 049	Advanced metering infrastructure for residential and commercial customers

Switchgear	
IEC 60898	Electrical accessories - circuit breakers for overcurrent protection for household and similar installations
IEC 61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's)
IEC 60269	Low-Voltage fuses
SANS 62271- 100 /IEC 62271 - 100	High-voltage switchgear and control gear – Alternating Current Breakers
SANS 60694:2003/ IEC 60694:2002	Common specifications for high-voltage switchgear and control gear standards
SANS 1973-1 to 4	Low-voltage switchgear and control gear Assemblies Parts 1 to 4
SANS 1765:2003	Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA
SANS 60439-1 to 5 /IEC 60439-1 to 5	Low-voltage switchgear and control gear assemblies parts 1 to 5
SANS 60947 / IEC60947	Low-voltage switchgear and control gear
IEC 60529	Specification for degrees of protection provided by enclosures (IP code)
SANS 60439-1 to 5 /IEC 60439-1 to 5	Low-voltage switchgear and control gear assemblies parts 1 to 5
SANS 60947 / IEC60947	Low-voltage switchgear and control gear

Control and Monitoring System (CMS) Field Equipment, Cabling and Installation	
IEC 61850-7	Communication networks and systems for power utility automation - Part 7- 420: Basic communication structure – Distributed energy resources logical nodes
IEC 60870	Tele control equipment and systems. Remote control of photovoltaic power plants.
EIA/TIA 568	Standard for structured cabling
EIA/TIA 569	Standard for communication pathways and spaces
EIA/TIA 607	Standard for grounding and bonding of communication cabling
TIA/EIA 485	Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
SANS 10142-1-2012	The Wiring of Premises Part 1: Low-voltage installations
SANS 10340-1	Installation of telecommunication cables part 1: Fibre optic cables in buildings
SANS 10340-2	Installation of telecommunication cables part 2: Outdoor fibre optic cables
SANS 60794-1-1	Optical fibre cables - Part 1-1: Generic specification – General
SANS 60794-1-2	Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures
SANS 61312	Protection against lightning electromagnetic impulse
SABS 1411: Parts 2-6	Materials of Insulated Electric Cables and Flexible Cords
SANS 60947-7-1 and 60947-7-2	The terminal blocks for the junction box terminations
SANS 60429	Degree of protections provided by enclosures (IP)

Inspection, Testing and Commissioning	
IEC 62446	Grid connected photovoltaic systems – Minimum requirements for System documentation, commissioning tests & Inspections
IEC 60364 – 6 Ed. 1	Low Voltage Electrical installations,
IEC 62337	Commissioning of Electrical, Instrumentation and Control systems
IEC 62381	Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)
IEC 62382	Electrical and Instrumentation loop check activities
IEC 62337	Commissioning of electrical, instrumentation & control systems
IEC 61724	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis

Plant Coding and Labelling	
ISO 10007:2003	Guidelines for configuration management

VGB-R 171e VGB	Guideline - Provision of Technical Documentation (Technical Plant Data, Documents) for Power Plants, 2nd Edition 2010

Fire Safety Standards	
SANS 10400-T:2011	South African National Standard Part T: Fire Protection
SANS 10139	Fire detection and alarm systems for buildings - System design, installation and servicing
	International Fire Code 2012

Non-Lethal Energised Perimeter Detection System	
SANS 10222-3	Electrical Security installations – Part 3: Electric fences (non- lethal)
SANS 60335-2-76	Household and similar electrical Energizers – Safety, Part 2-76: Particular requirements for electric fence energizers
SANS 60335-1	Household and similar electrical appliances – Safety, Part 1: General requirements
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 61000-1-2	Electromagnetic compatibility – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena

Security Lighting	
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
SANS 475	Luminaires for interior lighting, street lighting and floodlighting – Performance requirements
SANS 1088	Luminaire entries and spigots
SANS 1091	National colour standard
SANS 10108	The classification of hazardous locations and the selection of equipment for use in such locations
SANS 10389-1	Exterior lighting: Part 1: Artificial lighting of exterior areas for work and safety
SANS 10389-2	Exterior security lighting
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 60598-1	Luminaires Part 1: General requirements and tests
SANS 62262,	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
SANS 61347-1,	Lamp control gear Part 1: General and safety requirements.
SANS 61347-2-13,	Lamp control gear Part 2-13: Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules.
SANS 62031	LED modules for general lighting - Safety specifications.
SANS 62384,	DC or AC supplied electronic control gear for LED modules - Performance requirements

SANS 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specification
EN 55015,	Limits and methods of measurement of radio disturbance of electrical lighting or equipment.
EN 61000-3-2,	Electromagnetic compatibility (EMC) Limits for harmonic current emissions
EN 61000-3-3,	Electromagnetic compatibility (EMC) - Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low- voltage supply systems
EN 61547	Equipment for general lighting purposes: EMC immunity requirements
IEC-EN 62471	Photo biological Safety of Lamps and Lamp Systems for LED's
IES LM-79-08	Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM80,	Approved Method: Measuring lumen maintenance of LED light sources
ARP 035	Guidelines for the installation and maintenance of street lighting
	Electromagnetic Compatibility (EMC) Directive (2014/30/EU)
	Low Voltage (LV) Directive (2014/35/EU) Directives.

CCTV System	
SANS470	Concrete poles for telephone, power and lighting purposes
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations
SANS 10222-5-2	Electrical security installations Part 5-2: CCTV installations – Application guidelines.
SANS 10222-5-1-1, Part 5-1-1:	CCTV surveillance systems for use in security applications — Operational requirements
IEEE 1613-2009	IEEE Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations
IEC 60255-1	Measuring relays and protection equipment – Part 1: Common requirements
IEC 60721-3-3	Classification of groups of environmental parameters and their severities – Stationary use at weather protected locations

The PV Contractor must ensure that the complete system, including the equipment and installation conforms to the Occupational Health and Safety Act and its associated regulations.

Also, the systems and their components shall be manufactured and designed to the appropriate standards, including but not limited to:

1 SANS 10142 Part 1, Wiring of Premises – Electrical Installations.
2 SANS 10142 Part 3, Wiring of Premises – Embedded Generation.
3 SANS 10142 Part 5, Wiring of Premises – Direct Current and Photovoltaic.
4 NRS 097-2-1 (Part 2: Small Scale Embedded Generation, Section 1).
5 NRS 097-2-2.
6 NRS 097-2-3 (Part 2: Small Scale Embedded Generation, Section 3).

7 COCT Municipality Guidelines for Embedded Generation.
8 COCT Municipality's Electricity By-Law 2014.
9 NERSA Regulatory Framework on Small Scale Embedded Generation.
10 IEC 61215.

CONTENTS

3 PART III: PARTICULAR SPECIFICATION

3.1 SECTION A: GENERAL REQUIREMENTS

3.1.1 LOCATION

The works included under this contract will be undertaken within the premises of **SANSA Space Station in** Farm No 502 JQ, Hartebeesthoek, District Krugersdorp Mogale City Local Municipality.

3.1.2 EXTENT OF CONTRACT

The works is for the supply, delivery to site, storage, installation, servicing, maintenance, offloading, construction, erection, installation, off-site testing, on-site testing, commissioning, metering and reporting, performance testing, preparation of all detail workshop drawings, as-built record drawings, maintenance manuals and instructions for the works, in accordance with the general requirements and performance requirements as detailed in this document of a fully operational Photovoltaic Solar Systems.

The Photovoltaic Solar Systems shall comprise of solar generation, inverters, a battery energy storage and bypass system, as per manufacturer's guidelines, codes described within this document, that provide central photovoltaic Solar control and remote monitoring of the intended site, including the interfacing of all new and existing facilities.

The contractor will also be responsible for the registration of the system with the Supply Authority and any other Relevant Authority.

Prospective contractors shall be required to familiarize themselves with the conditions of the site, existing plants and equipment.

The works will be let as a Direct Contract to the Employer for the entire duration of the Principal Building Contract from date of appointment.

Prospective contractors shall be responsible for the supply, delivery, testing and installation of all necessary modules, equipment, hardware, cables, protective switchgear, accessories and work specified within this document. All equipment within this document shall have a minimum guarantee of 36 months on all components and workmanship.

All mounting structures necessary for the mounting of roof-top solar panels and the like shall be supplied and installed by the successful specifier under this contract.

The extent of the contract works shall include cabling necessary to distribute power to the main LT distribution board installed by the electrical contractor and providing the performance as specified in this contract document.

All cable enclosures including conduits, cable trays, ducts, wall boxes, termination panels and the like that are required to facilitate and complete the installation shall be supplied and installed as part of this contract.

QUANTITIES CANNOT BE GUARANTEED. Bidders shall quote for all equipment and all accessories specified within these documents. The procurement of the equipment and services shall be spread over the contract period. Servicing and maintenance of newly installed equipment and components and guaranteeing free defects for the full defects' liability period form part of this contract. Bidders must fully comply with all mandatory requirements. Failure to comply with this

requirement below will be regarded as mandatory non-performance and will cause immediate disqualification.

The prospective contractor should note that the design and bill of materials provided in this document is strictly a guideline. This contract is to be conducted on a Construct basis; hence the successful bidder is required to provide comprehensive 'workshop' drawings in line with requirements as outlined in this specification.

in line with requirements as outlined in this specification

3.1.3 NOTICE TO PROSPECTIVE CONTRACTORS

The contractor will be obligated in terms of this contract to ensure first delivery of equipment within a period of 4 weeks (28 days), after receiving an official appointment form and/or in terms of the approved Program of Works.

The contractor shall fully acquaint themself with the nature of the work carried out, the locality of the plant and any possible hindrances in the execution of the installation, services and maintenance and allow for these entire factors in their price, as any later claim based on unforeseen events or knowledge will not be entertained.

The contractor shall be entirely responsible for referencing all relevant standard specifications and/or other applicable published standards whether such standard is referenced in this document or not and ensuring compliance with the Engineering Works therewith. The references in this document to standard specifications shall not be construed as limiting and are given merely as a guide for basic reference. Where SABS is stated, the applicable SANS shall apply. It is a specific condition that if it is necessary to replace any equipment, (not part of this contract) that the SANSA reserves the right to source additional quotations and to accept a specific quotation, in term of the SANSA acquisition regulation and standard.

SANSA further reserves the right to accept or decline such variations. During the contract, all the systems, installations and equipment shall be supplied, installed and repaired as specified in this specification. The repair work shall include but not be limited to the specified specification details. All repair work shall be executed with approved materials and equipment suitable to the systems and/or installations they serve. The said installation and maintenance work shall be executed in accordance with the relevant codes of practice, standards, regulations, municipal laws and by-laws, manufacturer's specifications and codes of practice and all additional and particular specifications included in this document.

3.1.4 LETTING OF CONTRACT

The contract will be let as a Direct contract with the Principal Contractor for the entire duration of the Principal Building Contract from date of appointment.

3.1.5 MATERIAL REQUIREMENTS

This specification must be read with and shall form part of the Technical Specification contained in this document and/or from the approved specifications. **Bidders may submit quotes for standard equipment which comply with the specification required by SANSA, however, specific equipment must comply**

with the preferred specification indicated in the Technical Specification. Any deviation from the specification must be fully defined. All connections, installations and terminations of the required cabling and switch gear will form part this contract. **Full particulars, performance curve and illustration of the equipment offered must be handed in together with the quotation**

3.1.6 CONSTRUCTION PROGRAMME

The contractor's construction programme shall be aligned with the Employer's timelines, requirements and shall include allowance for adverse weather conditions, builder's holidays and public holidays as specified in the Principal Contractor's conditions of contract.

The programme for major tasks during the contract period should be agreed between the Contractor and the Project Manager before work commences. The Contractor shall thereafter submit a detailed installation programme for approval within two (2) weeks of the contract being awarded unless otherwise indicated herein after. The minimum time required to respond to a work instruction will, however, be as stipulated in Part T1.2, Bid Data, hereof, i.e. pages no's T1.2.4 to T1.2.10.

Submission of an outline programme is required in terms of the tender submission requirements as detailed hereafter. The detailed programme must be updated regularly as the work progresses and as may be necessary to meet changing site conditions and alterations to the overall installation programme.

Programmes shall take the form of bar charts, network diagrams and schedules as may be required by the Engineer or Contractor or as applicable, and shall reflect quantities of work as required for supervision purposes and measurements.

As a minimum the detailed programme shall reflect:

- sequence and timing of installation activities.
- sequence and latest event times of major equipment ordering, manufacture and delivery dates.
- sequence and dates for the submission of drawings and samples for approval.
- sequence and dates for site inspections and tests.
- target and achieved work quantities on a weekly, fortnightly and monthly basis.

3.1.7 WORKS PRIORITIZATION

It shall be the contractor's responsibility to plan and arrange his works according to his programme. The sequence in which the work is to be carried out shall be decided upon in consultation with the Project Manager and/or Engineer. The contractor shall complete the installation within the time stipulated.

3.1.8 DRAWINGS

The drawings as referenced in this tender document are schematic and do not show the exact dimension or positions of equipment. Tenderers must satisfy themselves that the equipment offered by them will fit in available space and can be positioned so that access for maintenance. Repair or removal is not encumbered.

No later than 8 weeks after access to site, or receiving instruction, the successful tenderer shall submit to the Engineer two copies of the detailed workshop drawings showing the required equipment, single line diagrams, dimensions, conduit boxes, position of equipment, cable trays, ducts, etc. These drawings shall only be created after a thorough site inspection and discussions with other relevant parties to ensure that the conduits, trunking, trays, etc. indicated on the drawings will be feasible to install. It must also be ensured that the complete installation is according to the specifications and standards.

Review by the Engineer of the drawings submitted by the contractor shall not relieve him of his liability to carry out the work in accordance with requirements of the contract documents.

NOTE: Final dimensions must be taken on site before any equipment or material is either purchased or manufactured.

Where air-conditioning ducts, etc. are being installed in the space to be protected, the contractor shall consult the main contractor for any information in this regard before being completing his detailed working drawings.

3.1.9 ELECTRICAL SUPPLIES

The contractor shall however allow for the connection of his equipment to the electrical supply points, changeover panel and the main LT distribution board. Any electrical reticulation in the inverter room and cabinets shall be done by the contractor.

All cabling and wiring required by the equipment shall be installed in dedicated sleeves, cable trays or wire ways. Tenderers shall allow for all cabling required to complete the installations as specified.

All equipment, fittings and materials shall be suited for the following electrical supply.

DC Supply:	Up to 48V
Single Phase AC Supply;	230 V ±10%
Three Phase AC Supply;	400 V ±10%
Frequency;	50Hz

Plug-top power supplies and plug adaptors will not be allowed.

3.1.10 HEALTH AND SAFETY

The Contractor shall adhere to the provisions of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993), and includes the Construction Regulations (2003), as amended.

Where relevant, allowance has been made in the Bills of Quantities for the Tenderer to allow for the costs involved to compile a Health and Safety Plan as per the Construction Regulations and to implement it for the duration of a specific task. This Plan must be submitted to the Engineer for approval before such a task commences.

3.1.11 SAFETY PROCEDURES

The Contractor shall not perform work on any portion of an electrical network until such portion of a network has been isolated and earthed and the work shall be

carried out under the full time supervision of a competent person as required by the OSH Act.

The Contractor shall request a written OSH Work Permit from the Engineer or his Representative, which shall be completed in duplicate. The original permit shall be retained by the Contractor until completion of his work. Upon completion of the work, the Contractor shall sign a statement to this effect. He shall hand this statement as well as the used permit to the Engineer or his Representative, to enable the latter to re-energise the relevant portion of the network.

The Contractor shall have and use where required the necessary safety equipment on the work assigned to him. No work shall be undertaken unless this requirement can be met.

3.1.12 PROTECTION OF WORKS

The contractor will be responsible for taking all necessary precautions for the protection of lives, equipment and materials, installations of structures in the vicinity of the works during installation and commissioning.

Any damage caused by the contractor, his agents or workmen to the building, structure finishes or any other installations will be made good by the contractor at his own expense and to the entire satisfaction of the Engineer.

3.1.13 STORAGE

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

3.1.14 EXISTING WORKS

The Contractor shall be responsible for obtaining information regarding services and the existing works which may be affected by the new works and maintenance work.

Before the Contractor commences operations, he must discuss with and have the approval of the Project Manager concerned regarding the method he proposes to use for the safeguarding of any services and existing works he may encounter during construction.

A comprehensive inventory of materials removed from the existing installation shall be recorded by the contractor in the presence of the consulting engineer or his representative and a copy shall be immediately issued.

The cost of all precautionary measures, which may be necessary to ensure the safety of such services and existing works, as well as the protection of all persons, shall be borne by the Contractor. Any alteration to services, which may be required, shall be carried out by the Authority concerned at the expense of the Contractor. The Contractor shall be held responsible for any damage, injury or accident caused as a result of his failure to take the necessary precautionary measures.

3.1.15 SITE STAFF

The Contractor shall have a competent person / supervisor on site at all times to oversee the execution of the work required under this contract. This person shall

be familiar and have undergone the necessary training to meet all the health and safety requirements stipulated in the Occupational Health and Safety Act (OHS Act) and where relevant to meet environmental procedures and the requirements of SANSA.

The person in charge will also ensure that the necessary quality control is applied. The contractor shall, with the engineer's or his representative's approval formulate a construction management plan to ensure that the process of works, variations, instructions, problems, incidence or accidence is recorded. The following is the minimum documentation that should be provided for site and project management:

- Site diary
- Staff on site
- Schedule of equipment
- Schedule of material
- Programme
- Site instruction / record book.
- Full set of the latest project drawings and as-built drawings (of all services)
- Communication schedule

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

3.1.16 LICENSED ELECTRICIANS

All electrical site work, including the installation of meters, solar PV panels and inverters shall be done by electricians licensed to carry out such work at the locality.

All installation work must be performed by accredited installers and documentation proving such accreditation must be submitted with this tender.

3.1.17 COMPETENT PERSONS

It is a definite requirement that competent engineers, technicians and electricians shall be used to install, commission, test, service, maintain and repair the systems. An alternative person with similar qualifications and experience shall be identified in case the preferred person is not available.

The names, with identity numbers and standards of competence, for all staff to be utilised will need to be provided as part of this Tender.

The Client requires competent persons with in-depth experience of the following fields;

- Photovoltaic DC Generation
- Ground Mounted Structure
- DC-AC Inverters
- Large Capacity Battery Storage Systems
- Internet Network Connection
- Smart Metering Technology
- Low Voltage Distribution and Protection
- Building Management System (BMS)
- Generator Integration

- Hardware and software setup and configuration.

3.1.18 WORKMANSHIP

The PV system contractor shall employ (if necessary) only competent artisans to perform construction and installation work on the site.

The contract shall be executed with the best workmanship in a workmanlike manner to the satisfaction of the Employer. Should any workmanship not be to the satisfaction of the Employer, it shall be rectified at the cost of the PV system contractor.

The PV system contractor shall remain responsible for the correct and complete delivery of the installation. Inspection by the Employer shall not release the PV system contractor from his responsibility.

3.1.19 MATERIAL QUALITY

Only material of high quality and suitable for the climatic conditions of the site shall be used and shall be subject to approval of the Employer and Engineer. All material shall conform in respect of quality, manufacture, tests and performance, with the requirements of the latest issue of the relevant SANS or where no such standards exist, conform to the appropriate current IEC Specifications. Materials manufactured in South Africa shall as far as possible be used and where applicable shall bear the SABS mark. Imported materials shall comply with the requirements of the appropriate I.E.C. specification. All materials shall be suitable for the conditions under which the materials are installed and used.

All equipment and components new and unused, unless materials taken from existing installation, shall be of high quality, the most recent models and suitable for the intended application. Special attention shall be given to the availability of spare parts and support for at least 5 years after handing over.

All materials and equipment used will be free from rust, defeats, undamaged and be suitable for the purpose for which it will be used.

If any material or workmanship is not to the satisfaction of the Engineer. It will be rectified and/or replaced at the contractor s cost and all rejected material will immediately be removed from the site. The contractor is responsible for the correct and complete erection of the installation and inspections do not exempt the contractor of this obligation.

The Contractor will ensure that no damage to installations undertaken by others results from work done by himself or those employed by him to complete the installations under his scope of works.

Should the materials or components not be suitable for temporary use under site conditions, then the PV system contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.

3.1.20 ATTENDING FOR MEASUREMENT

The Contractor, or his Representative shall, from time to time, when required on reasonable notice by the Engineer, attend at the Works to take jointly with the Engineer or his Representative any measurements of the work executed that may

be necessary for the purpose of preparing the Contractor's claim. Any such measurements when ascertained and any differences arising thereon, shall be duly recorded in the manner required by the Engineer.

The Contractor shall, without extra charge, provide assistance with every appliance and other thing necessary for measuring the work. If the Contractor's Representative fails to attend when so required, the Engineer or his Representative shall have power to proceed by himself to take such measurements and to prepare the final quantities, and in that case any decision of the Engineer shall be final and conclusive.

3.1.21 EARTHING, BONDING AND SURGE PROTECTION

The Contractor shall be responsible for all earthing and bonding of the equipment supplied or upgraded under his contract. The earthing and bonding of equipment shall be suitable for the application and according regulations.

The contractor shall provide high quality surge protection equipment to protect the equipment. The contractor shall provide high quality surge protection equipment to protect the equipment.

The Contractor shall use the use the services of a surge protection specialist, approved by the Engineer, to determine what surge protection is required and to what standard the surge protection should be installed.

3.1.22 ENVIRONMENT

All components shall be properly protected against possible environmental condition.

All galvanising shall be heavy, hot dipped galvanising suitable for corrosive areas. Painting and finishes shall also be suitable for corrosive areas.

All screws, bolts, supports and other components shall be galvanised, stainless steel or shall be protected by another suitable method against the expected corrosive environments.

3.1.23 LABELLING AND SIGNAGE

C3.1.30.1 Signage

The contractor shall allow for all signage required. The signs shall contain enough information to allow the general person to successfully use the systems. Only high quality us the systems. Only high-quality signs shall be acceptable.

At least the following signs shall be allowed for;

- At security doors in the inverter room and electrical room describing the operations of the equipment in a graphical nature.
- All equipment including inverters, battery packs, distribution boxes, wire terminals and cables shall be provided with unique numbers on high quality labels.
- Operating and troubleshooting guidelines shall be provided at equipment used by the general person such as LCD user interface on inverters and battery packs and user apps.

- Signage drawings shall be approved by the Engineer prior to manufacture/purchase.

C3.1.30.2 Labels

All equipment shall have unique number on a permanent label and fixed to the equipment. These numbers shall correspond with that on the drawings and in manuals. Labels. Shall be made of durable material incorporating clear and indelible markings and shall make use of firm, permanent adhesive.

C3.1.30.3 Design and Operating Information

Design information of replaceable parts, such as batteries and fuses, shall be indicated close to each part.

Complete schematic, wiring diagrams and operating instructions shall be laminated and fixed on the inside of all enclosures, kiosks and cabinets or on the wall next to a system in an approved manner.

C3.1.30.4 Cable Numbers

All cables shall be marked. At least the following requirements shall be met for all cable types;

1) Cables shall be numbered as follows
    a) Cables shall be numbered with permanent labels fixed to the cables
    b) Cables numbers shall be installed at each end of the cable, in each manhole and on each side of sleeves or other penetrations.
    c) Cables shall be numbered as follows
2) A cable schedule must be drawn up and submitted to the Engineer. The cable schedule shall have the following information;
    a) Type of cable (e.g. armoured, screened, e t c)
    b) Number of conductors [e.g.4 pair cable]
    c) Size of the conductors [e.g. 1mm2]
    d) Purpose of each core or pair
    e) Start and end point of each cable

3) Cable labelling shall comprise robust, PVC-type labels clamped to cable, not the adhesive label type.

3.1.24 RECORD KEEPING AND LOGBOOKS

A record shall be kept of each inspection and every test in a logbook kept in the inverter station. The logbook shall state at least the following.

- The date, name of the person and company.
- Details with comments of repairs, adjustments, replacements, tests, inspections, etc.

The replacement dates of items replaced shall be written on the item e.g. the replacement date of batteries, cameras, components, etc.

Special holders shall be provided for the logbooks and other operating information.

3.1.25 FINISHING AND TIDYING

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

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

3.1.26 TRAINING

The Contractor shall provide instructors to train the Client, service, operating and maintenance personnel. Separate operation training and technical training sessions shall be provided. Three sets of Approved Training Manuals are to be provided. Refresher training sessions shall be provided as required [but at least every 3 months] until the end of the guarantee period.

3.1.27 GUARANTEE

The Contractor shall guarantee to the Employer the material, equipment and workmanship delivered by him, for a period of at least 36 months which include parts and labour. The guarantee must be valid for a period starting on the date when the Works or portion thereof are accepted by the Engineer as complete and in working condition. The complete installation must be guaranteed against defects as a result of patent and latent defects of the design and equipment, save design defects made or specified by the Engineer, as well as against faulty materials and workmanship. Fair wear and tear is excluded from the guarantee.

The guarantee must provide that all material, equipment, parts, spares and appurtenances that become defective during the guarantee period be replaced free of charge of any nature to the Employer or Engineer. The costs of labour and transportation required to replace such part of a defective installation shall be borne by the Contractor and shall be included in his guarantee. The Contractor shall cede to the Employer the remainder of any guarantee which he has received from his Suppliers and which extends beyond the period mentioned herein.

If it becomes necessary for the Contractor to replace or remove any defective portions of the Works under this condition, the provisions thereof shall apply to the portions so renewed or replaced until the expiry of the guarantee from the date of such replacement or renewal, and in the event of any defects occurring or being discovered in or to the Works within the guarantee period as aforesaid, the guarantee shall continue until the defects have been made good to the satisfaction of the Engineer.

If any defects are not remedied within a reasonable time, the Employer shall proceed to have the work done at the risk and expense of the Contractor, but without prejudice to any other rights, which the Employer may have against the Contractor in respect of such defects

3.1.28 MAINTENANCE

The Contractor shall inform the Engineer or his Representative in routine operating, maintenance and servicing procedures of all items of plant supplied under this Contract, and shall ensure that he fully understands the manuals provided.

A 12-month free comprehensive maintenance period that runs concurrently with the first 12 months of the guarantee period shall be applicable in this contract.

A competent person shall inspect the system at least once every month during the free maintenance period. He/she shall attend to any problems requiring his/her attention, who shall:

i) Check the mechanical soundness of all parts.
ii) Check and adjust all the output and control parameters of the system (voltage, frequency, control voltages, etc.).
iii) Take control measurements on the major system components and record these measurements.
iv) Replace all defective components.

Maintenance Manuals are to be provided, and Scheduled Maintenance is to be verified by the Competent Person with copies of signed Maintenance Schedules forwarded to the Engineer and the Client Representative.

An extended maintenance service may be required. SANSA will negotiate a service agreement outside of this contract. *Should the free maintenance period lapse after final works completion, it is advisable that the extended maintenance must take place with immediate effect.*

3.1.29 COMPLETION DOCUMENTATION

On completion of the works, the EPC shall provide as-built drawings of the installation. The EPC shall also provide 3 sets of prints of these drawings bound into three (3) sets of the operating and maintenance manuals. Soft copies in pdf format are also required on a USB drive.

3.1.29.1 Operating Manuals

Three complete sets of the Operating Manuals, in English shall be provided. All the information in the manuals shall also be supplied in electronic format. A draft version of the Operating Manual(s) shall be submitted to the Engineer, at least two (2) weeks prior to the anticipated first handover of the installations, for review and possible amendment.

NOTE; these manuals shall contain no technical information. This shall be included in the Maintenance Manuals.

These manuals are be used by the User's personnel who will operate the system. The Operating Manuals shall be in the form of plastic display binders, and shall contain the following;

1. Complete operating instructions
2. Procedures during alarm and activation bringing back into operation after an alarm.
3. Detailed instruction of any procedure to be performed during or after alarm or emergency conditions.

4. Names, telephone and facsimile numbers and addresses of contact personnel.

3.1.29.2 Maintenance Manuals

Three complete printed sets of the Maintenance Manuals in English shall be provided. All the information in the manuals shall also be supplied in electronic format.

A draft version of the Maintenance Manual[s] shall be submitted to the Engineer, at least two [2] weeks prior to the anticipated first handover of the installations for scrutinising and possible amending. These draft manuals shall be in printed and electronic format.

The manuals shall contain the following as a minimum;

1. A complete set of' as built' drawings of the contract showing equipment positions, layouts, layouts, routes, etc.
2. No drawings shall be smaller than A4 SIZE. Large drawings shall be reduced to A3 or A4 size for inclusion in the manuals provided they remain legible. However, a set of' Full Scale' drawings is also to be provided.
3. The complete set of workshop drawings of the contract, showing dimensions, finishes, general arrangements of panels, consoles, computer assemblies, etc.
4. A single line diagram drawing showing all equipment and interconnections.
5. Wiring diagrams showing wire numbers. Terminal numbers, cables, equipment, etc.
6. A complete list of all equipment containing the following information;
    - Name of the equipment (or description thereof).
    - Serial numbers of equipment.
    - Type number of equipment.
    - Manufacturer of equipment.
    - Equivalent replacement model of equipment [Where applicable].
    - Name, addresses, telephone and facsimile numbers of companies supplying the equipment.
7. A complete and comprehensive description of the operation of the system and of each individual piece of equipment.
8. A complete and comprehensive description of the maintenance of the system and of each individual piece of equipment in respect of daily, weekly, monthly or annual maintenance.
9. Advance technical information of the system may also be bound into Manuals as additional information any literature not in English language shall have the English translation attached.
10. Manufacturers Catalogues.
11. A complete listing of all the configuration and programming information. Enough information must be supplied so that a system can be reconfigured by a person not knowledgeable of the site.
12. All relevant usernames and passwords.
13. Copies of all software, configuration, licences, etc.
14. Complete sets of design information the contractor was issued with by the engineer, for all portions of

15. Commissioning sheet and installation checklist.
16. Array frame engineering certificates for wind and mechanical loading.
17. Site-specific structural engineering certificate signed by a structural engineer.
18. Installer/designer declaration of compliance.
19. Warranty information on all supplied equipment.
20. A copy of the Certificate of Compliance for Electrical Safety.
21. All municipal, Eskom and other approvals.
22. Space within the manual must be provided for the maintenance history of PV installation to be recorded.

3.1.29.3 Electronic Copy

All the printed information and drawings in the manuals shall also be supplied on a CD in PDF format all project specific material shall be provided in the format of the original program that was used to create the material. The following formats are preferred;

1. Drawings; AutoCAD .DWG format
2. Sketches; Visio .VSD format
3. Documents; Microsoft Word .DOC format, and Excel for spreadsheets and schedules.
4. RTU or PLC programming; IEC 1131 format

3.1.30 SPARE HOLDINGS

Bidders are required to determine and include a practical, reasonable schedule indicating a sufficient number of spare equipment items for' attic stock', in their Bill of Materials to allow the User Client to change out faulty equipment in the shortest possible timeframe thereby ensuring continuity of operations.

Bidders must allow for spares allocation under the maintenance item in the Bill of Materials, in line with their experience and expertise.

3.1.31 INSPECTION, TESTING AND COMMISSIONING

After completion of the works and before first delivery is taken, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installation will be inspected and the contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.

The installation shall be deemed to be completed when it has passed all necessary tests and has been approved to the satisfaction of the distribution company.

Note:

i) All instrumentation necessary for testing shall be provided by the PV system contractor.
ii) The results of the above tests clearly recorded, signed, a complete set of test and commissioning sheets must be handed to the Engineer.
iii) Once the Engineer has inspected the complete installation and satisfied himself that all testing has been completed and the Contract is complete in all respects, the Engineer may be approached in writing with the above documentation with a view to arranging a hand-over date.
iv) On completion of the Contract, the PV system contractor shall provide the Engineer with a complete and signed Certificate of Compliance for

Electrical Installations as required by the Occupational Health and Safety Act as amended.

v) The contractor shall carry out commissioning and final acceptance tests as required by the project manager and as specified.
vi) Commissioning test must be performed in accordance with standards. To ensure all the solar equipment are operating correctly including solar panels, panel strings, inverters, meter, data logger and electrical protection devices. Final acceptance tests shall be done in the presence of the project manager and shall conform to standards

The contractor shall provide a Certificate of Electrical Safety for the installation and include a copy in the manuals. The contractor must also provide a report that includes voltage and temperature measurements, the current and irradiance measurements, the earth fault protection test and also states the conditions of the PV array wiring after the test, including any repairs and corrections carried out as a result of the inspections.

3.1.32 SUBMITTALS

The following information MUST accompany the tender documents at submission:

1. A paragraph by paragraph schedule of compliance with detailed description of any deviations from this specification.
2. A clear description of the operating characteristics and special features of the equipment.
3. Descriptive and illustrated brochures and other information pertaining to the solar PV panels, framing system, LED monitor and computer.

3.1.33 WARRANTIES

PV panels, inverters, batteries and EV charger shall all have a minimum product warranty of 10 years where such warranties shall ensure the replacement of the equipment due to failure.

All other products shall have warranties in line with normal OEM specified duration.

All warranties shall be in the name of the client and provided by the equipment OEM.

3.2 SECTION B: SPECIFIC REQUIREMENTS

3.2.1 GENERAL

This section of the specification shall be read as an amplification of the general requirements (Section A) with particular reference to the project being tendered upon. It covers the specific technical requirements for the equipment, materials, installation, testing, commissioning, and maintenance of a photovoltaic solar system for the **Solar Photovoltaic Plant at SANSA Space Station Krugersdorp** in the Mogale City Local Municipality.

In all cases the installation standards and regulations detailed in parts I & II shall be adhered to unless specifically mentioned to the contrary in this section. The Contractor shall take into account his programme, service interruptions so as to minimize any disruptions and that the work covers three (3) sites in the same premises, for plants 1, 2 and 3.

The drawings issued herewith and listed in the relevant section are to be read in conjunction with the specification and all items mentioned, together with all ancillary equipment necessary for the correct installation, operation and full compliance with the Standards and Codes must be provided, notwithstanding the fact that they may not have been included in detail in these documents.

"Contractor" shall mean the person, partnership, company or firm appointed for the supply, installation, testing, commissioning and maintenance of the Photovoltaic Solar System Installation. In the case of the PV specialist being a Principal Contractor appointed in terms of the Principal Contract Agreement or Direct Contract Agreement with the employer or otherwise, the word "Contractor" shall also mean "Main Contractor" or “PV Contractor” in terms of the Principal Contract/Direct Contract Conditions for the specific installation.

3.2.2 SITE CONDITIONS AND WORK ENVIRONMENT

The site information is described in table 1 below with the service conditions as follows:

Table 3-1: Site Information and contact details

INFORMATION REQUIRED	DESCRIPTION / NAME
Property Name	SANSA Space Operations
Project Physical Address	Farm No 502 JQ, Hartebeesthoek, District Krugersdorp
Municipal Area	Mogale City Local Municipality
Stand Number	Farm No 502 JQ
Stand Size	TBC
Plant 1 GPS Co-ordinates	-25.887713, 27.707355
Plant 2 GPS Co-ordinates	-25.886478, 27.704848
Plant 3 GPS Co-ordinates	-25.885279, 27.707543
Site Soil Conditions	To be established
Altitude:	~ 1 696 m
Peak Temperatures in 24 hours:	28°C Peak
Average Temperature in 24 hours:	16°C
Minimum:	-4°C
Humidity at Average Maximum Temperature:	58% RH
Lightning Conditions:	Isoeraunic Level 70

The contractor must note that the works implementation will be on a “LIVE ENVIRONMENT”, adequate allowances should be made to ensure minimal disturbance to the operations of the station. Should the contractor, want to work through the night/weekend, the necessary arrangement and approval must be sought.

The major contractor's site access and entrance criteria, OHS regulations, and the certification and identification of workers are only a few of the specific requirements that must be followed.

3.2.3 SITE VISIT

Tenderers must, before submitting their tenders, acquaint themselves with the local site conditions, accessibility of the sites, soil conditions, availability of labour and labour conditions, transport, off-loading, storage and custody conditions for materials and equipment necessary for the completion of the total contract. No claim based on ignorance in this regard shall be considered.

Permission must be obtained from the Employer’s Agent before any Tenderer visits the site, or the contractor establishes himself on the site.

3.2.4 COMPLIANCE WITH REGULATIONS

The installation shall be erected and carried out in compliance with:

i) The Occupational Health and Safety Act 85 of 1993 and incorporated regulations.
ii) The local Municipal by-laws and regulations as well as the regulations of the local Supply Authority.
iii) The local Fire Regulations.
iv) The Standard Regulations of any Government Department or public service company where applicable, such as Telkom, Neotel etc.
v) All regulations and standards as indicated in mentioned in part II.
vi) NRS 097 Grid interconnection of Embedded Generation.
vii) The installation must comply with *IEC 60364-7-712.*

The tenderer shall at his cost issue all required workshop drawings and notices in respect of modification of the installation to the local authorities and shall indemnify and exempt the Employer/Client from all losses, costs or expenditure which may arise as a result of the Photovoltaic (PV) Specialist Contractor’s negligence to comply with the requirements of the regulations stipulated above. No work shall commence by the Photovoltaic (PV) Specialist Contractor prior to the approvals by the local authority, of the relevant drawings or applications to perform work.

It shall be assumed that the Photovoltaic (PV) Specialist Contractor is conversant with the abovementioned requirements. Should any requirement, by-law or regulation, which contradicts the requirements of this document, apply or become applicable during erection of the installation, such requirement, by-law or regulation shall overrule this document and the Photovoltaic (PV) Specialist Contractor shall immediately inform the Principal Agent of such a contradiction. Under no circumstances shall the Photovoltaic (PV) Specialist Contractor carry out variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Employer.

3.2.5 SCOPE OF WORKS

The contract comprises the complete photovoltaic solar installation which shall include the entirety of the components, equipment, work & systems required, notwithstanding that may not be described in detail or their entirety below. The installations shall include but not be limited to the items listed below. The

Contractor must carry out all works necessary for the full and functional, reliable and safe operation of the complete Solar and Battery Backup installations including cable reticulation and tie-in to the Main Low Voltage Distribution Boards (MLVP).

This scope of work covers three (3) Photovoltaic (PV) plants, namely:

a) Plant 1: 200 kWp of solar PV generation.
b) Plant 2: 150 kWp of solar PV generation.
c) Plant 3: 150 kWp of solar PV generation.

The following section further outlines the scope of work of the contractor.

General Responsibility

The contractor shall be the Principal Contractor and shall enter into a building agreement with the South African National Space Agency (SANSA). The contractor shall be responsible for surveying, supply of all materials and labour, manufacture, delivery to site, offloading, construction erection, installation, off-site testing, on-site testing, commissioning, performance testing, provision of samples, provision of all detailed workshop drawings, as-built record drawings, maintenance manuals and instruction for the Works, in accordance with the general requirements and performance requirements as detailed in this tender for a fully functioning fixed PV system installation.

Civil Works

Ground Mount support structure: All required supporting ground mounted support structure and structural assessment to be provided and installed by the contractor.

PV Facility

Photovoltaic modules (single manufacturer, model, power class) and inverters.

Battery Storage

Battery storage (single manufacturer, model, power class) and inverters.

Electrical System

DC and AC reticulation, switchboards, cable containment, electrical protection, overvoltage, surge protection, Earthing and Lightning Protection, energy metering, power quality measurement and monitoring meter.

Control and Monitoring System

CMS system, user interface, communications network cabling, instrumentation, weather and plant performance monitoring system.

Security System

Perimeter fence during construction, security bolts to fix panels, warning signs, fire, electrical and lightning safety.

Operation and Maintenance

Responsible for the operations and maintenance of the facility for the first

Grid connection

The contractor is responsible for grid connection approval, required grid connection studies and any secondary network grid protection relays as required by the

distributor and South African Standards.

The contractor is responsible for all relevant notices, arranging for inspections and testing, paying all fees to the distributor and other authorities as required in connection with the solar PV installation.

The contractor is responsible for managing and organizing any meter upgrades or replacements at the site required for the solar installation

3.2.6 GENERAL PV FACILITIES REQUIREMENTS

The works comprises of the PV solar generation (module arrays) facilities as well as all associated infrastructure and balance of system (BOS) and shall be suitable for the expected climatic conditions at the site.

For Plant 1:

The PV arrays shall provide an approximate total output of 200kWp and be a PV hybrid system with battery backup, associated communication and display elements.

For Plant 2:

The PV arrays shall provide an approximate total output of 150kWp and be a PV hybrid system with battery backup, associated communication and display elements.

For Plant 3:

The PV arrays shall provide an approximate total output of 150kWp and be a PV hybrid system with battery backup, associated communication and display elements.

The facility must have a useful life of a minimum of 25 years without major overhaul or replacement of part.

The module's orientation (North or East-West) and the module's inclination shall be chosen as such to maximize performance.

Any direct coupling onto the existing electrical installation or alterations to the existing electrical installation shall be done with the approval of the electrical consulting engineer and shall be coordinated with the appointed electrical contractor. This does not exempt the PV contractor from issuing a certificate of compliance for his intended works, according to SANS 1012 Part 1.

The installation of the Facilities shall respect all local regulations, including the DTI Solar PV designation for local content as approved by National Treasury.

The facility should have an average first year annual minimum guarantee performance ratio of [78.6%] or greater.

3.2.7 GENERAL CONTRACTOR REQUIREMENTS

The Contractor shall be responsible for the workshop details, drawings and installation of the works. The installation shall respect international best practice and fit for purpose, complying with this specification and local national requirements. All installations shall be risk assessed by the installer and certified

for recognized standards including IEC. The risk assessment and certification shall be documented and submitted to the Consulting Engineer with the relevant workshop details submission.

The facility shall be constructed to avoid completely (where possible) or minimize risk to health and safety.

The Contractor is responsible for:

- Surveying the proposed sites
- Producing detailed workshop drawings

during the construction, operation, maintenance and decommissioning periods. The works comprise the solar array PV facilities as well as all associated infrastructure and balance of plant.

3.2.8 ENGINEERS DRAWINGS

Annexure A comprises a list of the drawings to be used for this tender document. The list is not exhaustive. Drawing numbers as listed and included in this tender document are to be read in conjunction with this specification.

The drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed. Drawings are limited in scope to specific components of a complete system and are thus a single line and 2D/3D representation of the system.

The position of power points, switches and distribution panels that may be influenced by built-in furniture must be established on site, prior to these items being built in.

The lines connecting devices shown on this drawing shall not be construed as exact cable routes between source and devices/appliances. These are tentative and it is the responsibility of the contractor to provide the most effective and efficient routes in accordance with regulations and industry best practices.

Annexure A comprises a list of the drawings to be used for this contract. The list is not exhaustive.

3.2.9 WORKSHOP DRAWINGS (Specific workshop drawing requirements)

Prior to commencement of the installation of the solar system, the contractor shall provide detailed documentation and shop drawings for approval by the engineer. The contractor shall provide shop drawings a minimum of 2 weeks prior to the proposed construction commencement date for approval.

The Pre-installation and shop drawings shall include as a minimum:

- Proposed module panel array (tables) layout drawings plan view for each array which are fully labelled and scaled in A1 format. This shall include proposed panel orientation, spacing between panel rows and proposed mounting/fixing details.
- Structural details of the array mounting showing the
  - all side elevations, including cantilevers
  - details of planting the struts to the ground,
  - rail and purlins sectional details
  - girders fixing details
  - module, mid-clamp and end-clamp assembly

- AC protection, DC combine boxes and mains distributions board details showing
    - dimensions of the board
    - all components such as switchgear, SPDs, busbars, neutral and earth terminals
    - all side elevations
- Floor plan layout with exact dimensions of the equipment inside the container showing positions of
    - The battery pack
    - inverters
    - AC and DC protection boxes
    - Fire suppression system
- Container side elevation and assembly
- Container mounting plinth details where necessary
- Struts mounting plinth details where necessary
- Datasheets with OEM drawings for
    - Inverters
    - Modules

3.2.10 SYSTEM DESCRIPTION

It is therefore the responsibility of the PV Contractor to make the required application to the supply authority on their standard documentation and to ensure that the system installed complies with their standards and specifications. See appendix A for the supply authorities standards and specifications and appendix B for their standard application form for embedded generation.

The PV Contractor must ensure that the complete system, including the equipment and installation conforms to the Occupational Health and Safety Act and its associated regulations.

Also, the systems and their components shall be manufactured and designed to the appropriate standards, including but not limited to:

1 SANS 10142 Part 1, Wiring of Premises – Electrical Installations.
2 SANS 10142 Part 3, Wiring of Premises – Embedded Generation.
3 SANS 10142 Part 5, Wiring of Premises – Direct Current and Photovoltaic.
4 NRS 097-2-1 (Part 2: Small Scale Embedded Generation, Section 1).
5 NRS 097-2-2.
6 NRS 097-2-3 (Part 2: Small Scale Embedded Generation, Section 3).
7 COCT Municipality Guidelines for Embedded Generation.
8 COCT Municipality's Electricity By-Law 2014.
9 NERSA Regulatory Framework on Small Scale Embedded Generation.
10 IEC 61215.

The PV arrays shall be mounted on the ground mounted structure to be done by the main contractor. The racking structure shall be constructed by the PV contractor. The following drawings and information is attached to support the installation of the PV system:

1. Appendix C: Drawings

2. Appendix D: Estimated Load Profile

The overall installation shall include, but not be limited to:

PV array: Modules of mono-crystalline, positively sorted, minimum 20-year manufacturer warrantee, to fit onto the ground mount structure within the parking lots identified. Each stringed array shall be supplied with a suitably sized disconnect switch.

PV array racking framework: All required racking framework for the system and fixings is to be provided and installed by PV contractor. The ground mount support system weight requirements, and layout to be coordinated with ground mount and structural drawings. Any and all mounting points of the supporting framework to the ground structure shall be made to conform to any and all design suggestions made by the responsible structural engineer.

Ground Mount support structure: All required supporting ground mounted support structure to be provided and installed by the main contractor.

Modular hybrid inverters: Three (3)-phase hybrid inverters which comply with any and all local and national by-laws with regard to PV hybrid systems shall be used. An isolated connection point shall be provided by the Electrical Contractor. The inverters shall be installed in the inverter room or as indicated by the electrical engineer or architect.

Batteries: Three (3)-phase hybrid inverters which comply with any and all local and national by-laws with regard to PV hybrid systems shall be used. An isolated connection point shall be provided by the Electrical Contractor. The inverters shall be installed in the inverter room or as indicated by the electrical engineer or architect.

Maximum power point tracking (MPPT): The inverters must be equipped with MPPT incorporated for power optimization of the system and these modules must be compatible with the manufacturer's specifications.

Modular communication: The inverters shall have built-in and/or be connected to a data acquisition and control unit so that the system can be monitored and adjusted locally and remotely. A data point shall be provided by the IT contractor which will have access to the internet. Both the Client and the Engineer shall require full access to the recorded data, locally and remotely, via the data collection portal.

Metering monitors: Meter interfaces shall be installed along with the main metering for the building.

Additional requirements include the following:

- DC cabling and containment
- AC cabling and containment

The PV Contractor shall liaise with Eskom to ensure that the system is installed and commissioned in accordance with their requirements and ensure that the necessary arrangements are in place for connection to and operation in parallel with the electrical mains supply.

The PV Contractor shall liaise with the Electrical Contractor in conjunction with the LV switchboard manufacturer to ensure that the correct equipment is installed and coordinated in accordance with their requirements.

3.2.11 PRINCIPLES OF OPERATION

The Solar PV System shall be utilised to provide power during grid failure or load shedding, with the priority source being the PV array and battery pack. Should insufficient power be generated from the PV array, power shall be sourced from the battery pack to power the electrical needs.

In the event that the battery reserve charge has fallen below the 20-30% threshold, then the system should allow for the 1.9MVA generator set to start up automatically and provide power to both the batteries and the facility via a communication system comprised of controllers.

3.2.12 EQUIPMENT TECHNICAL REQUIREMENTS

3.2.11.1 SOLAR PV PANELS

Table 3-2: Solar PV Panel requirements

Standards	IEC61215 and IEC 61730 certified (including the MST-23 Class C fire test)
Bloomberg's New Energy Finance Tier Rating listing	Tier 1
Design Wp DC	555Wp (indicative)
Cell:	Mono-crystalline or Poly or multi-crystalline
Power tolerance:	0 to +5W
Maximum Temperature co- efficient (P max)	-0.45%/°C or less (i.e. between zero and -0.45)
Normal Operating Cell temperature	45°C +/-2°C
Glass	Tempered or toughened glass minimum 3mm thickness
Frame Material	Panels installed >5° above horizontal: Panel framing shall be anodized aluminium alloy or equivalent; or frameless glass on glass panels. Panels installed <5° above horizontal: frameless glass on glass panels shall be provided.
Cable size	6mm
Connectors	Multi Contact MC4 or approved equivalent (IP65 min), must be corrosion resistant. Connectors elsewhere in the solar installation shall be of exactly the same type and manufacture as those provided on the solar PV modules.
Integral bypass diode protection:	Solar PV modules shall be furnished with 3 (min) bypass diodes integrated into the module junction box.
	At least 90% at 10 years At least 80% at 25 years

Performance Warranty:	Any insurance guarantee underwriting the long- term performance warranty should be specified, such as third party insurance arrangements.
Manufacturing warranty	10 years from date of installation Any insurance guarantee underwriting the long-term manufacturing warranty should be specified, such as third party insurance arrangements.

The contractor must provide technical datasheets of the proposed solar PV panels.

Table 3-3: Preferred Solar PV Panel manufacture requirements

Manufacturer South African Presence	Preference will be given to panel manufacturers that have a South African office and employees. Preference given to manufacturers that have South African based technical support, servicing and warranty claim service.
Warranty and Degradation	Preference given to panels that have annual lineal performance output warranty. In addition, independently tested degradation (PID) performance characteristics shall be preferred.
Manufacturer's Company History and experience	Longer than 5 years in PV manufacturing
Manufacturers quality assurance procedures	Documented quality assurance required. ISO accreditation highly regarded.

Table 3-4: Preferred Solar PV panel certifications, standards and schemes.

Standard/Certification scheme	**Description/parameter**
VDE Quality Tested	Preference given to panels that are VDE quality tested and certified or certified with a similar independent third-party testing organization that provides continuous quarterly testing for reliability and degradation.
Photon Laboratory International test results	Preference given to panel manufacturers that have PV panels highest on the most current Photon Test result.
IEC61853 – 1	Preference given to panels that have documented evidence of IEC61853 compliance/certification and details of module performance at 23 different temperature and irradiance conditions

3.2.11.2 INVERTERS

Table 3-5: Inverters technical requirements

Standards	Approved list of inverters
Efficiency	>96.5% European weighted inverter efficiency factor or equivalent >96.5% Peak efficiency
Ingress protection rating	IP65 (min), or suitable for the proposed inverter location
Three-phase	Provide a fully balanced three phase AC output
Metering	Be compatible with the University approved meter provider
Warranty	10 years required from date of installation, and include full onsite replacement of a faulty unit Any insurance guarantee underwriting the long-term performance warranty should be specified, such as third party insurance arrangements.

Table 3-6: Inverters manufacturer requirements

Supply history	Inverter manufacturers shall have a minimum of 7 years inverter manufacturing history.
Manufacturer South African Presence	Inverter manufactures shall have an South African office and South African based employees.
Engineering Technical support	Inverters shall have South African based engineering technical support services, including a dedicated customer support local phone number.
Servicing	Inverters shall have an in-house South African based servicing team, or team of certified A-grade electrician servicing partners.
Warranty support	Inverter shall have an South African based warranty support team and systems.

The contractor must provide documented proof that technical information on the proposed inverter is in compliance with above.

3.2.11.3 SOLAR SYSTEM MONITORING AND METERING

3.2.11.3.1 Meter supply and installation

The bidder shall supply and install energy metering inside the LV section of the minisub: A complete metering solution shall include but not limited to energy meters, CTs, VTs and CT and VT test Blocks. The energy meter shall provide tariff metering, and bi-directional energy measurements.

The Energy meter shall communicate with the respective control and instrumentation devices. The minimum communication protocol is RS485.

3.2.11.3.2 The Control and Monitoring System

The Control and Monitoring System comprises of data acquisition servers and onsite user interfaces, power supplies to control and monitoring equipment, UPS,

communication network cablings, instrumentation, fire detection system, weather and performance monitoring system.

Control and monitoring equipment shall be housed in the custom-made container. The CMS shall monitor the inverter parameters, Meteorological parameters, string currents and system status as minimum both local at site and remotely. The Bidder shall procure, install, test and commission the entire CMS scope as specified in the Works Information.

Remote monitoring shall be facilitated through a web-based user-interface and shall enable multiple users to login at the same time.

PV power plant monitoring, data logging and display shall provide the following minimum functionality:

- Stamped system data logs for analysis with suitable PC.
- Integration with the clients existing BMS system.
- Metering and instrumentation for display of systems parameters and system status indication.
- Temperature probes for recording the solar panel temperature and/or ambient temperature shall be provided and integrated into the data logging system.
- The following parameters shall be accessible via the BMS and Web based interface in real time for the solar power plant:
    - AC output voltage
    - AC output current
    - Output power production
    - Output power factor
    - DC input voltage
    - DC input current
    - System active time
    - System disabled time
    - System idle time
    - Energy production

- Adjustable protective function limits (AC over voltage, AC under voltage, over frequency, under frequency, ground fault, PV starting voltage and PV stopping voltage).
- The current values, previous values for up to a month, and the average values shall be made available for energy auditing.
- Data shall be recorded date wise and chronologically in a common worksheet. The data file shall be MS Excel compatible. Data shall be represented in both tabular and graphical form.
- Provision for real-time Internet monitoring and the download of historical data shall be provided.

Building Management System (BMS) Interface Requirements:

It is a specific requirement of this project that the EPC will engage with the Engineer to determine availability of a BMS at the facility and to coordinate the requirements to connect the inverters to the clients BMS if available. The EPC will be responsible for this integration from point of connection at the inverters to the

software platform. The client's BMS maintenance team will advise the EPC where to connect to the BMS LAN and will assist with the integration.

The BMS system shall provide monitoring and limited control functionality to the facility management personnel. Do note that the existing BMS system shall not replace any of the functionality of the system specific control system requirements (e.g. control loops, SCADA system etc.) required to make the system functional.

3.2.11.4 PV MOUNTING SYSTEMS

3.2.11.4.1 Framing and rail attachment

The contractor is to provide mounting details of the selected PV array in line with electrical drawings. The documentation is used as a guideline. Specific details of the mounting structure are to be provided in the tender submission.

Where clip-on or penetrative methods are used, equal spacing of the fixing method must be maintained and ensured for the useful life of the installation.

The contractor shall:

- Provide the installation manual identifying methods for safely constructing and securing the equipment on sites,
- Provide verification of the framing;
- Contractor shall provide information on how the frame is to be mounted on the ground mount structure to withhold against any wind , snow, water force to maintain this certification;
- The array frame shall be installed to the manufacturers recommendations to ensure the array frame meets certification, with consideration of the following:
    - Minimum spacing between fixing for the specific wind regime;
    - Type, length and gauge of screws to be used;
    - Number of screws required per fixing;
    - Size of batten/purlin required for fixing
    - Number of fixing and purling locations for non-penetrative fixtures
- The mounting frame/support for the PV arrays is to be weatherproof and corrosion resistant. The lifetime of the mounting structure must exceed the lifetime of the PV arrays.
- All dissimilar metals must be mechanically separated to prevent galvanic corrosion.
- Provide a minimum 10-year warranty on framing

The contractor is responsible to ensure adequate and safe connection of the module framing to the ground mount structure. The contractor is required to provide structural certification of the installed solar mounting system including pull test results of the ground structure for the installed solar PV system.

3.2.11.4.2 Structural engineering approval

The contractor is responsible for providing a letter and certification from a professional structural engineer on the structural suitability of the building(s) for the proposed solar PV installation(s).

The site-specific structural engineering letter should include:

- Confirmation of the ground suitability of the for the proposed ground mount PV system framing and panels including additional dead and wind loads.
- Maximum short-term deadloads possible during construction and recommended locations for deadloads, including total load from any unit of plant or equipment and total load to any single support point;
- Confirmation of the suitability of the recommended fixing systems of the solar PV framing, if not incompliance with the framing manufacturer instructions including maximum roof height and purlin spacing.

The contractor is responsible for any short-term loads during construction and adequate and safe attachment to the ground structure for the life of the system.

3.2.11.4.3 Key Requirements for Pull Tests

The contractor is responsible for providing test results and certification for the Pull Tests.

Site Assessment:

A thorough geotechnical investigation is crucial to understanding soil conditions and identify suitable locations for testing.

Test Anchor/Pile Installation:

Test anchors or piles (driven piles, helical piles, or earth screws) are installed at designated points, mimicking the actual foundation type used in the solar array.

Load Application:

A hydraulic jack or similar device is used to apply an upward force, gradually increasing it until the anchor is pulled out or reaches a predetermined load limit.

Data Collection and Analysis:

Accurate measurements of force and displacement are recorded throughout the test. This data is then analyzed to determine the anchor's pull-out resistance and its ability to withstand design loads.

Verification of Structural Design:

The pull test results are used to validate the structural design of the solar mounting system and ensure it meets the required safety and performance standards.

Testing at Varying Embedment Depths:

Tests should be conducted at different embedment depths to determine the optimal depth for the chosen foundation type.

Testing in Different Soil Conditions:

If the site has varying soil conditions, tests should be performed in each soil type to ensure consistent performance.

Personnel and Safety:

Dedicated personnel should monitor the tests, ensuring safety procedures are followed and the test area is properly marked.

Compliance with Standards:

The pull test procedure and results should be in line with relevant industry standards and regulations.

Types of Pull Tests:

Vertical Uplift Tests: Evaluate the resistance of the foundation to upward forces.

Lateral Load Tests: Assess the foundation's ability to withstand horizontal forces and moments.

Ultimate Vertical Uplift Tests: Determine the maximum vertical force the foundation can withstand under combined vertical and horizontal loads.

Importance of Pull Tests:

Optimize Foundation Design:

Pull tests help optimize the design of the foundation system, potentially reducing material costs and installation time.

Mitigate Risk:

They reduce the risk of structural failure due to inadequate holding capacity of the foundation.

Ensure Long-Term Reliability:

By verifying the foundation's ability to withstand anticipated loads, pull tests contribute to the long-term reliability and performance of the solar farm.

3.2.11.4.4 Warranty

The solar array mounting system and connection must be provided with a minimum manufacturing warranty of 10 years.

3.2.11.5 EQUIPMENT INSTALLATION

3.2.11.5.1 General

The system must comply with South African Installation guidelines.

3.2.11.5.2 Solar PV Array location

The contractor is responsible for conducting a shading assessment. A shading analysis has been conducted for the ground areas where required, in addition to identification of roof obstacles restricting the placement of solar PV arrays.

Designs that depart from that indicative PV array layout on the attached drawings are only permitted with the project manager’s written approval, provided the required overall solar PV capacity is maintained, and that all shading, roof obstacles, heritage and architectural issues are duly considered and confirmed.

General installation rules that must be strictly adhered are:

- The spacing of tilted panels must ensure that subsequent rows of panels are not adversely affected by shade between 10am and 2pm at the winter solstice.
- Panel arrays shall be located to ensure ease of access for maintenance and repair of the solar system.
- Panel arrays shall be located to ensure ease of access to all roof areas including all existing roof plant, anchor points and guttering.
- Flush mounted (non-tilted) panels must provide maintenance access of 600mm width every four rows of panels as a minimum or maintenance access of 300mm width every two rows of panels.

- All panels must be able to be safely and easily accessed, with any one panel able to be accessed by removed only one other panel.
- A minimum of 2m clearance shall be provided around significant items of plant that require ongoing maintenance, such as adjacent building structures east, west and north of the solar array.
- A minimum of 0.6m clearance shall be provided around fixed items of minor plant such as HVAC outdoor units.
- Be configured square to the closest building line in an orderly and visibly appealing fashion.
- Be located to minimize the effects of shade from surrounding infrastructure and vegetation.
- Avoid installing constructing arrays over existing cable, water and sewer services.

Panel orientation:

- It is preferred that tilted panels are installed between 15° to 20° above horizontal.
- Panels shall be installed at azimuths between 0° (N).

Where existing safety hardware exists the panel layout and design must consider the safe usage and access of this equipment, to ensure the safe ongoing usage of the equipment and original intended purpose of the equipment. Particular attention must be given to ensuring that either the existing or new anchors can be easily accessed by providing maintenance access channels at appropriate locations near the anchors.

3.2.11.5.3 Solar PV Array Installation

The installation must comply with all recommendations provided within the South African installation guidelines.

Wiring

Refer to the relevant standard(s).

Earthing

Refer to the relevant standard(s).

String Protection

Refer to the relevant standard(s).

PV isolator at array

Refer to the relevant standard(s).

PV array cable between array and inverter

Refer to the relevant standard(s).

Note that the site and client may have specific guidelines which must be adhered to.

3.2.11.5.4 Inverter Installation

Solar inverters shall require careful installation to ensure safety and optimal performance. The inverter installation shall be installed as per installation Guidelines, and the Design Guidelines.

Invertors shall be installed, in the custom-made containers namely, container 1, 2 & 3 to convert the DC voltage & current into AC voltage & current at the location near the miniature substations transformers for plant 1, 2 and 3 respectively.

The inverters shall be capable of withstanding the maximum array voltage and current they may encounter.

The inverters shall carry the IEC Type Test certificate (or from a recognized approval body as approved by the Engineer), or to the requirements of the Engineer (this approval must be in writing).

The invertors shall be in IP 65 rated enclosures and mounted so that they are easily accessible for maintenance.

The invertors shall automatically disconnect from the LV distribution system during a mains outage to prevent the photovoltaic systems working in island mode.

The front of the inverter enclosures shall incorporate the following sign ‘Inverter - isolate AC and DC before carrying out work’.

All the plants shall employ hybrid inverters as described in the drawings and this section of the specification.

For hybrid inverters

- Inverters must be located where they can receive adequate ventilation to not compromise inverter efficiency;
- Inverters are to be located so that they are not exposed to the weather, and not be in a location which has direct sunlight between 9am and 3pm at the equinox, the contractor is responsible for adequate shade and weatherproofing of the inverter location.
- Inverters are to be accessible to maintenance staff via a safe access point;
- Inverters must be protected by a vandal resistant steel cage/ventilated box or similar where the inverter is otherwise accessible to the public;
- Inverter shall have appropriate restricted access; the inverters must be provided where the system maximum voltage exceeds 600V,
- Inverters shall be installed as per the manufacturers guidelines.
- Solar panels: Connect the positive and negative cables from the solar panels to the corresponding terminals on the inverter, ensuring correct polarity.
- Batteries: Connect the battery cables to the battery terminals on the inverter, paying close attention to polarity.
- Grid (AC): Connect the inverter's output to your electrical distribution board using appropriate wiring and secure connections.
- Essential for safety: Proper grounding prevents electrical hazards and is a requirement of most electrical codes.
- Connect to a grounding rod: Ensure a grounding wire is connected from the inverter to a grounding rod.
- Track energy usage: Most hybrid inverters have monitoring software to help you track energy production and consumption.
- Configure the system: Set up the monitoring system to properly track and manage your solar energy system.
- Listed components: Use listed wires, circuit breakers, and other components as required by safety standards.

Each of the large inverter installations (150kW and 200kW) shall connect to a new PV tie-in AC protection box and from there connect to the LV cubicle of each miniature substation or main LV panel after the change-over.

The inverters will comply to the requirements as per the technical data sheets.

The inverters shall have a built-in bypass switch and shall also be connected to the AC Protection Boxes via a by pass cable.

All proposed locations for inverters are subject to approval by the Engineer/Client.

3.2.11.5.5 Earthing

All Systems installed as part of the delivery of the Works shall include an earthing system which is compliant with all aspects South African standards.

As a minimum, all conductive components of the system shall be earthed using a protective earthing conductor with a minimum cross section area of 6mm² to provide total earthing capacity to the System; as required by the System's size, capacity and configuration.

The earthing conductor must also connect to all cabinets and inverters, using either the cabinet proprietary attachment or other solution to obtain a permanent earthing fixture.

All hinged doors to cabinets must be fitted with a suitable sized and configured earthing strap between door and cabinet.

All components that have the potential to experience a differential in voltage (e.g. frames/mounting systems) particularly under fault conditions, shall be equipotential bonded using a bonding conductor which complies in terms of material, type, insulation, identification, installation and connection requirements as outlined in standards. The cross section sizing of the bonding conducted will be of sufficient capacity to accept the voltage levels produced by the System.

Standard:

Refer to the relevant standard(s).

3.2.11.5.6 Cabling

General:

AC and DC cables shall be selected in accordance with SANS 10142 Part 1, fully compliant with SANS 1507-3 and must satisfy the following maximum overall voltage drops:

Connection Maximum	Voltage Drop
DC wiring between the arrays and the inverters	< 3%
AC wiring between inverters and distribution boards	< 1 %

- Normal AC cable shall be of type 0.6/1kV X-90 insulated, PVC sheathed. 1 copper conducted 900C (XLPW) insulated and TPE sheathed.
- DC cabling shall be fine stranded tinned copper conductors.
- PV power plant DC cables shall be rated for installation in ambient temperatures with minimum range of -20°C to +90°C.

- All PV power plant DC cables and DC equipment shall be terminated with suitable rated and approved DC connecters. DC cable joints and terminations shall be fit for outdoor installation. Please observe the minimum ambient temperature range above.
- Cables shall be terminated correctly, suitably tagged, marked with proper manner by good quality ferule or by other means so that the cable is easily identified and labelled as per the design drawings.
- PV power plant cable penetrations shall be waterproofed to prevent water ingress in the cable shafts if/where applicable.
- The Cable should be so selected that it should be compatible up to the life of the solar PV panels i.e. 25 years.
- Cables should have Multi Strand, annealed high conductivity copper conductor on DC side and copper/FRLS type Aluminum conductor on AC side. For DC cabling, multicore cables shall not be used.

DC Cabling:

The PV modules shall be wired in strings to the invertors via DC cabling.

The DC cabling between the solar arrays and the invertors shall consist of purpose designed 80°C photo voltaic cables with purpose made PV plug and socket (MC4) connectors.

The cables shall be UV stable, water resistant and multi-stranded to allow for thermal/wind movement of arrays/modules.

The DC component ratings (cables, isolators/ disconnectors, switches, connectors, etc) of the system shall be sized to suit the maximum voltage and current of the PV arrays (and individual modules) taking into account the system voltage/currents of the series/parallel connected modules making up the array. Standard de-rating factors (temperature, solar gain grouping etc) shall be applied in accordance with SANS 10142 part 1.

DC Solar Cables are to be 1 x 6mm² multistrand tinned copper conductors with core insulation and sheath. Cables are to have a nominal voltage of 1,5kV with a max permissible voltage of 1.8kV and a permissible operating temperature of +120°C.

The DC elements (wiring, connectors etc) of the PV system shall incorporate Class II insulation (double insulation). DC junction boxes with negative and positive parts shall be separated and protected by barriers, or by utilising separate enclosures. Positive cable shall be identified by “Red” insulation and negative cable shall be identified by “Black” insulation.

The cable runs should be kept as short as practicably possible. Labels shall be installed along the DC cables with the following wording: “Danger solar PV array cable – high voltage DC - live during daylight”.

The PV Contractor shall supply and completely install all DC cables as indicated on the drawings. Cables are to reticulate in and be secured to a 150mm wide return flange cable tray (with cover) mounted to P2000, using cable ties and securing the cable at intervals of 500mm. All cable trunking and accessories shall be galvanized and be properly supported at intervals of at least 1500 mm.

The storage, transportation, handling and laying of the cables shall be according to first class practice, and the contractor shall have adequate and suitable equipment and labour to ensure that no damage is done to cables during such operations. DC cables installed underground shall be run together with bare Copper earth continuity conductors in polyethene sleeves for the entire length of the cable in the ground. Such continuity conductors are to be stranded of a cross-sectional area equal to at least half that of one positive conductor string of the cables but shall not be less than 6mm².

Above ground, the PV Contractor shall supply and install all the containment to support and protect the DC cabling. The DC cables shall be installed in earthed galvanized trunking, sleeve, cable tray etc., to provide mechanical protection. Galvanized conduit shall be hot-dipped inside and outside in accordance with SANS 32 & 121. The containment shall be fixed to the frames. Bonding of all steel structures must be in accordance with SANS 10142.

Cables reticulated in the ground shall be run in 50mm to 110mm diameter HDPE flexible sleeves. Minimum laying depths shall be 650mm below final ground level unless otherwise specified, and shall be 450mm wide for one to five strings of cable, and the width shall be increased where more than five strings of cables are laid together so that the cables may be placed at least two string diameters apart throughout the run. The bottom of the trench shall be level and clean and the bottom and sites free from rocks or stones liable to cause damage to the cable. Cable routes shall be as indicated on the drawings.

AC Cabling:

The invertors shall be connected to dedicated local 3-phase distribution boards which shall connect each PV installation to the low voltage network.

Size of neutral wire shall be equal to the size of phase wires, in a three-phase system.

Thermo-plastic clamps to be used to clamp the cables and conduits, at intervals not exceeding 50 cm.

The PV Specialist Contractor shall select and install the AC cables between the invertors and distribution boards in accordance with SANS 10142, Part 1.

The AC cables connecting the inverters to the distribution boards shall consist of XLPE/SWA/LSOH cables.

The distribution boards shall be located within adjacent risers or on the frame of the PV cells (within an IP 65 enclosure). If the distribution boards are not installed by the clients Electrical Contractor, the PV Specialist Contractor must supply a COC for each distribution board.

The PV Specialist Contractor shall provide and install the MCBs within the distribution boards and be sized to suit the requirements of the PV installations.

Suitably rated IP 65 manual isolators shall be mounted adjacent to each of the invertors to isolate the AC output of the invertors to facilitate the maintenance of the AC cable runs and inverters.

The isolators shall switch the live and neutral conductors.

The isolators shall clearly indicate the ON and OFF positions and be labelled as ‘PV system – AC isolator’ and be securable in the OFF position only. The isolator shall be secured using a standard padlock.

The AC cables shall be installed in or on containment provided and installed by the client’s Electrical Contractor, but the cables themselves shall be part of the PV installation.

Standard:

Refer to the relevant standard(s).

3.2.11.5.7 DC Protection Box

The DC protection box, often a combiner box in solar PV systems, are the crucial components for safely managing and distributing power from the multiple solar strings to the inverters. These shall be equipped with DC isolation switches in the form of 4P 16A miniature circuit breakers and shall be installed to provide a means of manually and automatically isolating each PV string.

The boxes shall be located adjacent to, or integrated into the associated inverters.

The switches shall be double poled and suitable for DC operation (load-break rated) to effectively isolate both PV string positive and negative poles.

The DC switches shall be rated for the maximum system voltage and current.

The DC switches shall be labelled ‘PV array DC isolator’, with the ON and OFF positions clearly marked.

The enclosures shall also be labelled with ‘Danger - contains live parts during daylight’.

The co shall be SANS 61439-1&2 certified and the OEM shall be one of the following, or equivalent reputable brands.

3.2.11.5.8 AC Protection Box and Mains Distribution Boards

The AC Protection Boxes namely, ACPB1, 2 and 3 shall control the AC power from inverter, and should have necessary surge arrestors, if required. Furthermore, they shall house the motorized changeover switch. There is interconnection from ACPB to mains at LT Bus bar while in grid tied mode.

All switches and the circuit breakers, connectors should conform to IEC 60947:2019, part I, II and III/ IS 60947 part I, II and III.

The isolators, cabling work should be undertaken as part of the project.

All the Panel’s shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on 1-ϕ / 3-ϕ, 415 or 230 volts, 50 Hz (or voltage levels as per CEA/State regulations).

The panels shall be designed for minimum expected ambient temperature of 450 C (degree Celsius), 80 percent humidity and dusty weather.

All indoor panels will have protection of IP 54 or better, as per site conditions. All outdoor panels will have protection of IP 65 or better, as per site conditions.

Should conform to SANS 10142 safety regulations (till last amendment).

All the 415 or 230 volts (or voltage levels as per regulations) AC devices / equipment like bus support insulators, circuit breakers, SPDs, Voltage Transformers (VTs) etc., mounted inside the switchgear shall be suitable for

continuous operation and satisfactory performance under the following supply conditions.

i) Variation in supply voltage: as per regulations
ii) Variation in supply frequency: as per regulations

The inverter output shall have the necessary rated AC surge arrestors, if required and MCB/ MCCB. RCCB shall be used for successful operation of the PV system, if inverter does not have required earth fault/residual current protection.

The AC protection boxes and mains distribution including the LV section of the miniature substation shall be SANS 61439-1&2 certified and the switchgear OEM shall be one of the following, or equivalent reputable brands.

- ABB
- Eaton
- Hager
- Legrand
- Logstrup
- Schneider
- Siemens

The EPC shall install the same manufacturers circuit breaker in the mini-sub as installed in the PV tie-in DB.

3.2.11.6 PV SYSTEM TO ELECTRICAL SYSTEM INTERFACING AND SYNCHRONIZATION

The network is equipped with 1.9MVA generator upstream. Main LV cables run from the secondary side of the transformer to the generator control panel where it is integrated with a 1.9MVA standby generator to feed a common busbar. Interfacing between the PV inverters and generator supplies might be required and shall be allowed for by the EPC.

In order to successfully integrate solar with already existing diesel generators, a controller such as electronic controller solution is needed. The interfacing will consist of power monitoring and will disconnect the PV in the event where the PV yield lowers the generator load to lower than 35% of the generator capacity. The generator must run at least 35% of the nominal power when it is switched on, the operator must ensure that this threshold is set in the electronic controller, and it has seamless communication with all the solar PV plants.

3.2.11.7 ZERO-EXPORT

The PV installation shall be so configured as to not export any energy into the grid.

The system shall however be able to export and shall be configured as such at a later date to be confirmed by the client.

The registration of the PV installation with the supply authority shall indicate that the system will export to the grid and the required metering (if any) shall be installed and configured day one.

3.2.11.8 GRID CONNECTION

The contractor is responsible for grid connection approval, required grid connection studies and any secondary network grid protection relays as required by the distributor and South African Standards.

The contractor is responsible for all relevant notices, arranging for inspections and testing, paying all fees to the distributor and other authorities as required in connection with the solar PV installation.

The contractor is responsible for managing and organizing any meter upgrades or replacements at the site required for the solar installation.

3.2.11.9 PV POWER PLANT PROTECTION

The following minimum PV power plant protection shall be provided:

- Lightning and surge protection. The aim of this protection shall be to reduce the overvoltage to a tolerable value before it reaches the PV system's sub-components. Lightning and Class II surge protection shall be installed to protect both the structure and equipment against the effect of lightning damage in accordance with SANS 62305.
- The PV arrays shall be protected against direct lightning strikes and protection shall be designed and installed by the clients lightning protection contractor as discussed elsewhere in this specification.
- All metal PV panel, cable and equipment supporting frames and cable ways shall be bonded and connected to the earth termination system with regular intervals in accordance with SANS 10142-1.
- The PV power plant shall be protected against ground faults.
- The PV power plant shall be protected against DC reverse polarity connection.
- The PV power plant shall be protected against AC and DC over- and under-voltages.
- The PV power plant shall be protected against overload conditions.

3.2.11.10 LABELLING

All labelling of the system shall be of trifoliate engraved type, adequately secured and screwed where exposed, and comply with the requirements in the installation guidelines

3.2.11.11 CONSTRUCTION PROGRAMME

The Contractor's programme shall be co-ordinated with the programme of the Principal Contractor and shall include allowance for adverse weather conditions, builder's holidays and public holidays as specified in the Principal Contractor's conditions of contract.

3.2.11.12 SAFETY

The contractor shall ensure safe installation and ongoing maintenance/cleaning of the solar system by providing additional roof safety hardware as required. The contractor, as part of the tender submission, shall detail and outline site specific safety issues and additional safety hardware to be installed to ensure safe installation and ongoing maintenance.

The contractor is responsible for:

- Replacing any anchors which are covered or not accessible due to the solar array,
- Installing new anchor points where required to ensure safe roof access to all areas of the solar array.

SANSA recognizes its obligations under the Occupational Health and Safety Act and is committed to promoting a healthy and safe working environment. All contractors must be accredited in accordance with SANSA's Health and Safety procedure and or Standard Practices Instructions (SPI) system before commencing work on site.

3.2.11.13 PRE-INSTALLATION DOCUMENTATION

Prior to commencement of the installation of the solar system, the contractor shall provide detailed documentation for approval by the engineer. These shall include but not limited to"

- Fully detailed Scope of works document including details of all equipment supplied and description of works as understood by the contractor.
- Project Safety Plan which, includes site specific information on project details, first aid representation of the install team, evacuation procedures and locations, site isolation and signage requirements, proposed work areas and access, project roles and responsibilities and OH&S site specific issues.
- Site specific Safe Work Method Statement.
- The supply authority grid connection approval form or approval letter.

3.2.11.14 DEFECTS LIABILITY PERIOD

A workmanship and defects liability period of minimum **three (3) years** on the entire installation of the system shall be provided from the date of Practical Completion.

The cost of all labour and materials expended in complying with the above shall be borne by the contractor.

3.2.11.15 COMMISSIONING

The installation shall be deemed to be completed when it has passed all necessary commissioning requirements and has been approved to the satisfaction of the client.

3.2.11.16 TRAINING

The EPC shall provide training to the clients technical and maintenance personnel and the training will consist of lectures, exercises and an exam covering how to monitor, operate and perform basic management and maintenance tasks on the PV power plant. Special attention shall be given to the emergency shutdown procedure of the PV system and battery installation.

Allowance shall be made to provide training and certification to a total of at least five personnel. The EPC will not be expected to charge extra if the client requires more than five staff to be trained.

The course curriculum shall be presented to the engineer for approval at least three weeks before the commissioning PV system.

The training of the client's personnel shall commence before, during and after PV system commissioning and be completed before practical completion.

3.2.11.17 PRACTICAL COMPLETION

The following items must, without exception, be completed prior to requesting the engineer to make final inspections for Practical Completion and the final invoice:

- Test the complete installation works and leave the work area in perfect and clean condition.
- Thoroughly clean all equipment and parts.
- Label all equipment.
- Prepare complete operating and maintenance instructions, warranty documentation and 'as-built' records to the approval of the engineer.
- Carry out all specified testing and commissioning.
- Supply Authority inspection of the completed installation and Certificate of Compliance for Electrical Safety.
- Supply all grid connection approval documentation from supply authority and or NERSA.
- Conduct training to client staff and building managers on safe operation of the system.
- Provide a detailed planned maintenance plan for the system, indicating daily, weekly, monthly, quarterly and annual maintenance to be carried out on the entire solar PV installation system.
- Physically switch on the system.
- Ensure that the monitoring systems are configured and operational.
- Ensure all relevant signage is installed.

ANNEXURE A DRAWINGS

DRAWINGS REGISTER		SIZE	REVISION
DRAWING NO.	**DESCRIPTION**		
12501-PV-SLD02	Single Line Diagram for Complete Solar PV Plant No. 1 (200kW)	A1	B
12501-PV-SLD03	Single Line Diagram for Complete Solar PV Plant No. 2 (150kW)	A1	B
12501-PV-SLD04	Single Line Diagram for Complete Solar PV Plant No. 3 (150kW)	A1	B
12501-PV-SLD05	DC Combiner Box (DCCB1) Single Line Diagram	A1	B
12501-PV-SLD06	DC Combiner Box (DCCB2) Single Line Diagram	A1	B
12501-PV-SLD07	DC Combiner Box (DCCB3) Single Line Diagram	A1	B
12501-PV-SLD11	Mains Distribution Board (MDB1) Single Line Diagram	A1	B
12501-PV-SLD12	AC Protection Box (ACPB1) Single Line Diagram	A1	B
12501-PV-SLD13	AC Protection Box (ACPB2) Single Line Diagram	A1	B
12501-PV-SLD14	AC Protection Box (ACPB3) Single Line Diagram	A1	B
12501-PV-SLD15	Battery Fused Protection Box (DCFB1) Single Line Diagram	A1	A
12501-PV-SLD16	Battery Fused Protection Box (DCFB2) Single Line Diagram	A1	A
12501-PV-EL02	Site Electrical Reticulation Layout of DC/LV Power for Complete Solar PV Plant No. 1 (200kW)	A0	B
12501-PV-EL03	Site Electrical Reticulation Layout of DC/LV Power for Complete Solar PV Plant No. 2 (150kW)	A0	B
12501-PV-EL04	Site Electrical Reticulation Layout of DC/LV Power for Complete Solar PV Plant No. 3 (150kW)	A0	B
12501-PV-EL05	Module Stringing Arrangement for Inverter 1	A1	A
12501-PV-EL06	Module Stringing Arrangement for Inverter 2	A1	A
12501-PV-EL07	Module Stringing Arrangement for Inverter 3	A1	A
12501-PV-EL08	Module Stringing Arrangement for Inverter 4	A1	A

ANNEXURE B SCHEDULE OF EQUIPMENT OFFERED

Note:

1 This Schedule must be completed for all items offered. Failure to comply with this requirement may render the Tender invalid.
2 Information in amplification of that given below may be submitted in the form of a covering letter, published literature, etc.
3 Acceptance of a tender, with this schedule complete, does not relieve the Tenderer of the responsibility of complying with the Specification for the items listed.

Item	Description	Manufacturer	Model
1	Solar PV Module		
2	Solar panel mounting structure and ballast system		
3	Solar DC Cable		
4	MC4 Connectors (Male & Female)		
5	32A SP Cartridge Type Fuse Holders		
6	16A SP Cartridge Type Fuse		
7	DP 1500V DC SPD Type 1 + 2		
8	150kW Hybrid Inverter		
9	200kW Hybrid Inverter		
10	215kWh HV Lithium Battery Pack		
11	630A TP MCCB with Trip setting characteristics		
12	425A TP MCCB with Trip setting characteristics		
13	325A TP MCCB with Trip setting characteristics		
14	630A, 400V, 4P Motorized Auto Change Over Switch		
15	240mm² 4C PVC/SWA/PVC Cu cable		
16	185mm² 4C PVC/SWA/PVC Cu cable		
17	AC Protection Box		
18	DC Protection Box		
19	Anti-Islanding Relay		
20	Datalogger		
21	Power Analyser		