

Notsi PV Project

Engineering, Procurement and Construction Contract

Schedule 2 – Employer's Requirements

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1. Introduction

1.1. General

This Employer's Requirements describes and makes reference to the minimum technical requirements for the Facility, including compliance, scope, design and execution requirements. The Contractor shall comply with all applicable legislation and requirements of the Contract, including the ERs.

Any approval, document, response or comment given by the Employer under or in connection with this Contract shall not relieve the Contractor of any responsibility under the Contract, except to the extent expressly provided.

1.2. Definitions and Abbreviations

In this ERs, the words and expressions established as definitions in the Contract and in other Schedules shall have the same meaning as assigned to them in such Contract and Schedules. The same shall apply for abbreviations.

1.2.1. Definitions

Access Road means any new or existing road between the S322 secondary road and the site entrances.

Contract means the Engineering Procurement, and Construction contract to which this Schedule 2 – Employer's Requirements applies

Contracted Capacity is defined in the Contract.

Contractor's Permits means all permits, which are necessary for the design, execution and completion of the Work and the remedying of any defects, but excluding the Employer Permits.

Contract Price is defined in the Contract.

Design Life means a period of 30 years commencing on the date of Taking Over.

Distribution Self-Build Agreement means the agreement governing the Eskom connection works to be built by the Contractor, on behalf of Eskom, as provided in Schedule 23 [*Related Document Obligations*].

Employer's Permits means the permits listed in Schedule 4 - Authorisations.

Energy Meter means any and all import or export meters applicable to the Facility, including any backup or check meters, as defined in the CUOSA.

Environmental Plan means a comprehensive document outlining how the Contractor will ensure it will comply with all environmental requirements of the Contract.

Facility means the PV system, which comprises PV modules, trackers, inverters, transformers, subsystems, cabling, associated metering and other civil and electrical works, constructed and installed as part of the Work.

Factory Acceptance Tests means tests to be completed by the original equipment manufacturer at the production facility for the relevant piece of equipment. Grid Network Service Provider means the counterparty to the CUOSA contained within Schedule 23 – Related Documents.

Health and Safety Plan means a comprehensive document outlining how the Contractor will ensure it will comply with all health and safety requirements of the ERs. The Health and Safety Plan will document, among other things, the Contractor's health and safety policy, and how it will ensure health and safety risks to its staff, and staff of the Employer, will be managed.

Independent Engineer means the independent consulting engineer or engineering company of international repute with relevant experience in photovoltaic electric power generation.

Initial Performance Test means the testing set out in Schedule 8 [Tests] which shall be performed prior to Taking Over.

Inspection and Test Plan means a document detailing all inspections and tests to be performed by the Contractor, Third Party auditors and the Employer, in order to ensure that the applicable equipment are produced in compliance with requirements of the Contract. The Inspection and Test Plan will include an overview of all tests to be performed throughout execution of the Works, along with detailed test sheets which will be completed during each test or inspection. All test sheets will be provided to the Employer once relevant tests are completed.

Interim Performance Test means the testing set out in Schedule 8 [Tests] which shall be performed 12 months after the Initial Performance Test.

Irradiance means the incident flux of radiant power per unit area, expressed in units of W/m².

Levelised Cost of Electricity means the cost of generating a fixed unit of electricity, as defined in Section 1.4.

Milestone Schedule means a milestone payment schedule included in Schedule 3 [Contract Price and Payment Schedule] of the Contract.

Notice to Proceed is defined in the Contract.

O&M Agreement is defined in the Contract.

Operator is defined in the Contract.

Performance Guarantees means a Performance Ratio in accordance with the provisions of Schedule 7 – Performance Guarantees of the Contract.

Performance Test is defined in Schedule 8.

Point of Connection means the point of PV plant connection to the grid network, as defined in the CUOSA.

Programme means a comprehensive document describing all Works to be performed by the Contractor and the timeframes in which these works will be completed. The Programme is included in Schedule 6 [Programme and Milestone Schedule].

Project Execution Plan means a comprehensive plan provided by the Contractor that documents how it will deliver its scope of work under the Contract.

PV Monitoring System Availability means the availability of the measured parameters required for the calculation of each Performance Tests. It shall be calculated computing the availability of each measured parameter during all 10- or 15-min Test Intervals of the Test Period as further defined in Schedule 8 [Tests].

Quality Plan means a comprehensive document outlining how the Contractor will ensure it will comply with all quality control and assurance requirements of the Contract. The Quality Plan will document, among other things, the Contractor's quality policy, its plans for audits, contents and timings of submission for the Inspection and Test Plan, how the Contractor will manage records and documentation, including demonstrating traceability of all materials, and how the Contractor will track and address non-conformances.

Recording Interval means time between records.

Sampling Interval means time between samples.

Site Conditions means prevailing meteorological, ground and other conditions experienced at the Site.

Spare Parts means a collection of materials and equipment stored at Site and supplied by the Contractor in order for the Operator to be able to perform timely scheduled and unscheduled maintenance on the Facility.

Standard Test Conditions is defined in the Contract.

Standards means an established norm or requirement in regard to technical systems specified at the international, national and local level.

Test Data means data collected during a Test specified in Schedule 8 [Tests]. The raw data is the data collected prior to applying any quality filter or data treatment to missing or invalid Test Intervals.

Test means all required technical activities to be performed to demonstrate the Facility and Work has been completed in accordance with the Contract. Tests include those specified in Schedule 8 [Tests], the Inspection and Test Plan, Quality Plan, the Contract and any other documentation.

Test Period means the time between commencement and finalisation of a Performance Test.

Test Results means the document provided by the Contractor to the Employer for review and acceptance or rejection including, but not limited, the raw data that were collected during the test, data quality check and data filtering and treatment, PR and availability calculations results.

Testing Schedules means Schedule 8 [Tests].

Transmission Self-Build Agreement means the agreement governing the Eskom connection works to be built by the Contractor, on behalf of Eskom, as provided in Schedule 23 [Related Document Obligations].

1.2.2. Abbreviations

Table 1: List of Abbreviations

Abbreviation	Abbreviated Expression
A	Ampere
AC	Alternating Current
AMR	Automatic Meter Reading
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
BoM	Bill of Materials
CCTV	Closed Circuit Television
CdTe	Cadmium Telluride
CIGS	Copper Indium Galium Selenide
CT	Current Transformer
DC	Direct Current
DIN	Deutsches Institut fuer Normung (German Institute for Standards)
EL	Electroluminescence
EN	European Standards
EPC	Engineering, Procurement, and Construction
ERs	Employer's Requirements
ESG	Environmental, Social and Governance
GHI	Global Horizontal Irradiance
GII	Global Inclined Irradiance
GNSP	Grid Network Service Provider
GPS	Global Positioning System

HV	High Voltage, which for the purposes of this Contract shall be 44 kV and above, unless defined otherwise in specific standards.
HVAC	Heating, Ventilation, and Air-Conditioning
IBC	International Building Code
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Devices such as MV or HV protection relays
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organisation
ITP	Inspection and Test Plan
LCOE	Levelised Cost of Electricity
LeTID	Light and Elevated Temperature Induced Degradation
LPS	Lightning Protection System
LPL	Lightning Protection Level
LRA	Lightning Risk Assessment
LV	Low voltage, which for the purposes of this Contract shall be 1,000V _{AC} or below and 1,500V _{DC} or below
MC	Multi-Contact
MV	Medium Voltage, which for the purposes of this contract shall be those voltage levels between LV and HV
NERSA	National Energy Regulator of South Africa
NTCSA	National Transmission Company South Africa
NTP	Notice to Proceed
O&M	Operations and Maintenance
PCB	Power Conversion Block
PEP	Project Execution Plan

PID	Potential Induced Degradation
PLC	Programmable Logic Controller
POA	Plane of Array
POC	Point of Connection
PPAs	Power Purchase Agreements
PR	Performance Ratio
PV	Photovoltaic
QA/QC	Quality Assurance / Quality Control
QHSE	Quality, Health, Safety, and Environment
RTU	Remote Terminal Unit
SANS	South African National Standards
SCADA	Supervisory Control and Data Acquisition
SLD	Single Line Diagram
STC	Standard Test Conditions
UPS	Uninterruptable Power Supply
UTC	Coordinated Universal Time
V	Volt
VA	Volt Ampere
VT	Voltage Transformer
W	Watt

1.3. Law, Permits, and Standards

The Contractor's obligation to comply with all relevant Authorisations and Standards shall include (but shall not be limited to) an obligation to comply with the following:

- The requirements of the Buyer;
- The requirements of Eskom;

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- The requirements of the NTCSA
- The Requirements of the NERSA;
- The requirements of the Related Documents;
- Relevant requirements of the Employer's Authorisations, which have been included in Schedule 4 [*Authorisations*];
- All Contractor's Authorisations;
- Any directive, requirement, instruction, order, or guideline issued by a manufacturer of goods, materials, and/or plant to be used by or installed into the Facility; and,
- Any industry norm or best practice.

Within 4 weeks of NTP of the Contract, the Contractor shall produce an exhaustive list of codes and Standards to apply to the design of the Facility for Employer comment.

The applicable regulations, standards and laws which are mentioned within this document, are to be regarded as non-exhaustive and do not relieve the Contractor from its obligation to provide complete and fully functional systems and facilities. The Contractor shall observe all the applicable laws, national and international standards which are relevant for completion of its Work under the Contract.

When a specific topic is not regulated by a national law or standard, the Work shall comply with the standards issued by the following organisations, in order of precedence:

- SANS;
- IEC;
- ISO; and,
- IEEE.

In the absence of any relevant SANS or international standards, EN Standards shall be used.

1.4. General Requirements

The Contractor shall provide a “turn-key” solar photovoltaic PV power plant, including related infrastructure, to export the generated power to the local electricity network up to the nominated Point of Connection. The Facility shall be constructed in compliance with the terms and obligations of the Contract and this ERs.

The Contractor shall be required to design, procure, construct and test all equipment and perform all services necessary for complete, safe and prudent operation and maintenance of the Facility by others, including information and training, even if not expressly stated in this ERs.

For the avoidance of doubt, it is the Contractor's responsibility to ensure that the Facility is designed to the latest applicable local and international design criteria and industry best practice.

Documentation provided by the Contractor shall be provided in English. Where indicated in Section 11, documents shall additionally be provided in English.

The Facility shall be located at the Site and shall have a Design Life of 30 years.

The Facility shall be designed, manufactured, configured and constructed in such a way that it shall achieve performance, availability and reliability in line with the Contract requirements. The designs, components and materials to be used by the Contractor shall be of proven quality and track record, having been satisfactorily used in recent project financed, utility scale, international PV projects.

The Facility shall be designed in such a way that the maximum power output (active power) measured at the Point of Connection shall not exceed the Contracted Capacity.

The Contractor, in consultation with the Employer, shall optimise the Facility's LCOE considering the design, operation and maintenance requirements for the Facility. The LCOE is calculated factoring in all costs associated with construction, operation, maintenance, decommissioning and rehabilitation of the Facility and Site, using methodology and assumptions considered appropriate by the Employer.

The LCOE will be calculated as:

Levelised Cost of Electricity

$$= \frac{(\text{discounted capital costs} + \text{discounted operational costs} + \text{discounted decommissioning costs})}{\text{discounted generation}}$$

Commissioning and completion testing of the Facility shall be undertaken by the Contractor. The tests will ensure that the Facility can operate and perform in accordance with these ERs and the Contract. Testing will be undertaken to verify the performance of the Facility, and successfully passing all tests will be a condition for achieving Completion.

2. Scope of the Works

The Contractor's overarching scope of Work is detailed in the following sections:

2.1. Quality, Health, Safety, and Environment

The Contractor will be required to:

- Implement and maintain a health and safety system compliant with ISO 45001 – Occupational health and safety, good industry practice, IFC Performance Standards, and all applicable Law and regulations (including the Occupational Health and Safety Act No. 85 of 1993;
- Implement and maintain a quality management system compliant with ISO 9001 and good industry practice; and
- Implement and maintain an environmental management system compliant with ISO 14001 — Environmental management system, good industry practice, and all applicable Law and regulations.

Within four weeks of Notice to Proceed ('NTP'), the Contractor will produce a project specific Health and Safety Plan, Quality Plan, and Environmental Plan which demonstrate how the Contractor will ensure compliance with requirements of the Contract. The Health and Safety Plan, Quality Plan, and Environmental Plan will be subject to Employer comment and will be strictly adhered to by the Contractor in performing the Work.

The Health and Safety Plan shall include:

- An emergency response plan which shall be produced in consultation with the Employer and all relevant stakeholders;
- Training matrix for all Contractor staff;
- Traffic management plan including:
 - speed restriction signage on internal and access roads;
 - speed enforcement and disciplinary actions; and,
 - appropriate barriers, chevrons and signage on all elevated roads;
- Schedule for completion of drills (fire, security, etc.);
- Fatigue management plan;
- Fall protection plan including the requirement for temporary life lines;
- Schedule for delivery of awareness campaigns, including mental health awareness programmes; and,
- All other topics to be covered by a qualified contractor acting in line with good industry practice.

The Employer reserves the right to audit any and all aspects of Contractor's health and safety system, quality management system and environmental management system to confirm work is being performed according to the Health and Safety Plan, Quality Plan and Environmental Plan. The Employer's audit rights will include attendance at Subcontractor and supplier facilities, either for isolated visits prior to or during production, or with a part-time or full-time presence. The Contractor shall ensure all documentation necessary to confirm the Contractor is in full compliance with requirements of the Contract is made available to the Employer and its

representatives. The Contractor will also ensure the Employer is able to attend all Factory Acceptance Tests.

2.2. Surveys, Studies, and Reports

The Contractor shall be responsible for verifying and interpreting all such data (as contained in the studies, surveys, etc.) and for properly taking into account all Site Conditions (including historical extreme events) in the design of the Facility. The Employer shall have no responsibility for the accuracy, sufficiency or completeness of any data, surveys, studies, and reports provided to the Contractor, and these documents are not to be considered reliance material.

The Contractor shall, as a minimum, prepare and complete the following surveys, studies and reports and undertake a detailed design for the Facility, suitable for the Site.

All geotechnical, geophysical and seismic investigations, soil electrical and thermal resistivity, on and off-site moisture content and sieve tests of cable bedding material, along with any other soil investigations;

- Topographic contour data and mapping/surveying;
- Flooding and drainage studies;
- Hydrology studies including required volume of water to construct, operate and maintain the Facility and how this water will be sourced;
- Grid connection and Grid Code compliance studies;
- Meteorology studies;
- Wind studies and associated load assessments (including but not limited to static, dynamic and fatigue loading);
- Energy resource analyses, performance ratio studies and energy yield estimations;
- Surveys to evaluate shading objects to include, if clearly visible, young trees or future construction projects that may reasonably be known which may affect future energy production;
- All necessary calculations for the civil, mechanical and electrical systems including but not limited to: all package specifications, structural (including foundation) loading calculations, drainage calculations, power loss calculations, fault level calculations, cable sizing calculations, fuse and switchgear sizing, earthing, bonding and lightning protection, insulation coordination, etc.;
- All necessary drawings including schematic drawings, building and station layouts, component specifications, all bulk material specifications arrangement and layout drawings, mounting structure and reinforcement drawings, trenching drawings, steel structure drawings, single line diagrams, typical construction drawings, etc.;
- All design documentation, construction drawings, maintenance manuals, start-up, commissioning and handover procedures; and,
- The Contractor shall be responsible for submitting all statutory and design code calculations for Third Party verification, and obtaining such approvals and certifications as required.

The design and construction of the Facility will be such that the Facility shall meet the Performance Guarantees and any other performance criteria that may be reasonably inferred or expected.

2.3. Preparatory Works

The Contractor shall be responsible for providing preparatory works, including but not limited to:

- Site preparation, including clearing and grubbing of land, conservation of topsoil, excavation, backfilling, compaction, grading, levelling, earth moving, soil improvement, and rehabilitation of parts of the Site as affected by the Contractor's activities;
- Obtain Contractor's Authorisations and maintain all Authorisations in full force and effect;
- Perform any activities required to comply with the Authorisations;
- Sourcing of external fill and grading material with proper origin certification;
- Site drainage and sewage systems;
- All necessary Site control measures during and after construction (i.e. erosion, flooding, and dust control);
- Preparation of stable foundations, in compliance with equipment manufacturers' requirements and specifications; and,
- Liaison with and accommodation of the interests third parties may have regarding the Site, the Facility or access or proximity thereto.

2.4. Infrastructure Works

The Contractor shall be responsible for providing infrastructure works, including:

- Construction, maintenance, and reinstatement of access roads and roads within the Site.
- Water and electricity supply required for construction;
- Internet and Wi-Fi connection with a minimum bandwidth of 10 Mega-bits per second, including providing unrestricted access to the Employer;
- Construction of all necessary sewage infrastructure to serve the Facility;
- Construction of electrical distribution system, water system, parking areas, etc.;
- Fencing, gates, and intruder alarm systems appropriate for the Site Conditions, in order to ensure safety and security of the Facility, equipment and personnel;
- Sourcing of water, energy, heat, compressed air and any other utility or form of energy needed during construction.
- Firefighting and first aid infrastructure;
- Spill kits to address any spillage control requirements for the Materials on site;
- Removal of temporary works after construction;
- Relocation of any cables and pipes (i.e. existing services and/or infrastructure) crossing the Site (if any), including any replacement materials required as a consequence of the relocation;
- Reinstatement of vegetation as per local environmental requirements;
- The Contractor is responsible for damage due to construction activities caused to private and public infrastructure inside and outside of the Site, and the restitution thereof, to the requirements and satisfaction of the relevant Employer's, users and authorities; and

- Any equipment required to comply with the Environmental Plan such as spill kits.

2.5. Construction Facilities

The Contractor shall be responsible for providing construction facilities, including:

- Provision of a suitable part of the Site for the location of the Contractor's facilities (including toilets, corresponding sewage treatment, catering), security control (Access control, security patrolling, etc.) and temporary storage. The location of the facilities shall be agreed with the Employer. If an off-site temporary construction compound is envisaged this shall only be permitted with the prior consent of the Employer and the Contractor shall be responsible for obtaining land lease, permits, and any costs associated with the off-site compound;
- Provision of temporary Contractor's offices, warehouses, workshops for construction, along with all vehicles, plant, mobile equipment, temporary power generators, and temporary air compressors (as required);
- Provision of temporary Employer's and owner's engineer offices and associated services (ablutions, electricity, HVAC, etc.) as further detailed in Section 9.18; and
- Removal of temporary construction facilities including complete rehabilitation of surface areas disturbed during construction.

2.6. Design and Engineering

The Contractor shall be responsible for all engineering and design activities related to the Facility, including the related Grid Connection Works, which form part of the Facility as further detailed in Section 2.11.

The detailed design and engineering shall achieve:

- An optimised LCOE;
- Optimised operation and maintenance of the Facility;
- Export capacity, measured at the Point of Connection, able to be curtailed to the Contracted Capacity;
- Maximise performance and availability (the Facility shall be designed such that availability shall meet or exceed 99%) of the Facility over its design life; and
- A design which can be manufactured, installed, operated and decommissioned safely over its lifetime. The Contractor shall propose and perform all studies necessary to achieve such a design, including any necessary hazard identification studies.

2.7. Procurement and Delivery

The Contractor shall procure, be responsible for and take care of, at its cost, the procurement, manufacturing, loading, unloading, transportation and logistics of all material, equipment and tools necessary for the execution of the Facility, including customs clearance and associated costs and maintaining the original equipment manufacturer's warranty.

In selecting components to be incorporated and integrated into the Facility, the Contractor shall evaluate the production quality, performance, efficiency, and reliability of current technologies

available, including the determination and mitigation of deficiencies and limitations of each component and/or technology with respect to Site Conditions, in order to achieve an optimised design, installation and performance.

The Contractor shall be responsible for care and custody of the Site, the Works, Materials and the Facility until Completion.

As part of its Quality Plan, the Contractor shall maintain a system to monitor delivery, storage and installation of Materials.

2.8. Transportation and Logistics

The Contractor shall be responsible for selecting all transport routes and arranging all necessary transport and logistics for its scope of work. The Contractor shall bear responsibility and assume all costs associated with:

- Any road or access modification or reinforcement required to transport the equipment to the Site from the place of origin.
- Any permit, license and approval required to transport the equipment to the Site from the place of origin.
- Any temporary storage facilities required during the transportation and logistics phase; and,
- Implementing GPS tracking for logistics vehicles.
- As part of its Environmental Plan, the Contractor must prepare a traffic management plan that complies with all relevant conditions of the Authorisations. The traffic management plan shall be subject to Employer comment. Where relevant, the traffic management plan will outline where sections of the route need to be modified to meet delivery requirements for Equipment or Materials. The Contractor shall be responsible for completing any road modifications required in order to comply with the traffic management plan. Roads must be re-stated to their original conditions prior to Completion unless agreed otherwise with the Employer and other relevant stakeholders.
- The Contractor must prepare a journey management plan that will outline the route, expected journey time and associated rest stops which hauliers will be required to adhere to. Travel times and associated rest periods will comply with local transport and logistics regulations.

Shock sensors shall be applied to module pallets or the trailers on which the module pallets are loaded prior to transport to detect shock loading above and beyond an acceptable level. A full visual inspection of all equipment arriving at Site shall be performed including checking shock sensors on module pallets.

2.9. Equipment and Systems

As a minimum the following equipment and systems are to be supplied by the Contractor as part of the Work:

- Solar PV modules;
- Inverters;
- Step-up transformers;

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- Mounting structures;
- Tracking systems;
- Cables (DC, AC, communication, fibre-optic, etc.);
- Containers and cabinets;
- Grid Connection Works;
- HVAC system as required;
- Fire protection systems;
- Electrical protection systems;
- LPS.
- Earthing and bonding system;
- Weather stations;
- SCADA system;
- Metering systems;
- Security and surveillance systems;
- Access control systems;
- Drainage systems;
- All consumables for construction and operation of the system until Completion;
- General site facilities;
- Water storage, processing, distribution, and array cabling systems;
- Waste-water system;
- Fire-fighting system;
- Signs and safety equipment;
- QHSE equipment and tools;
- A set of Spare Parts as defined in Schedule 12 [*Contractor Supplied Spare Parts*]; and,
- Any other equipment or component that, although not listed here, is necessary for the construction, connection to the grid and proper, safe and efficient operation of the Facility with due consideration of the Facility's design life.

The Contractor is responsible for providing all consumables it requires to construct the Facility in accordance with the Contract, to achieve Completion.

2.10. Construction

The Contractor shall be responsible for completing all construction works as necessary, including but not limited to:

2.10.1. Civil Works

- Soil bearing capacity improvements e.g. piling (as required);
- Clearing and mowing the site;
- PV module support structures and foundations;
- Concrete and steel-reinforced concrete works and foundations for equipment and buildings.
- General buildings, such as administrative building, control room, workshop, storage building, guard house, auxiliary buildings and structures;

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- Buildings for all mechanical and electrical equipment including buildings associated with the sub-station and Grid Connection Works;
- Cable trenching and duct systems;
- Facility and Site drainage and water control measures;
- Roads and surface drainage;
- Upgrading and maintenance of existing farm roads (including access roads) and the S322 secondary access road as required;
- Fencing access control and security systems;
- Site rehabilitation during construction works; and
- Civil works necessary to supply water to Site e.g. rain water harvesting, private water supply, connections to water main, etc.

2.10.2. Mechanical Works

- PV module installation;
- PV modules mounting structures, with tracker systems;
- Balance of mechanical equipment;
- Auxiliary systems, as far as applicable;
- HVAC to all buildings as applicable;
- Equipment for workshop, stores and other facilities, including storage racking;
- Erection of transmission line pylons;
- Cable trays;
- Structure for weather station;
- Cleaning of PV modules prior to undertaking performance testing;
- Fire detection and fire protection devices and equipment; and,
- Emergency power facilities where required.

2.10.3. Electrical Works

- Electrical string cables between modules;
- Electrical string cables between modules and combiner boxes or string inverters;
- Electrical cabling between combiner boxes and inverters (if applicable);
- MV switchgear and LV/MV transformers;
- SCADA system;
- Electrical equipment within the Facility substation;
- Control cabling;
- Metering system;
- Lightning protection system and system earthing;
- Installation of transmission line cabling;
- Installation of cabling to substations;
- Grid Connection Works;
- All required electrical protection;
- Electrical system related to security such as CCTVs and access control;
- Auxiliary power supply and connection; and

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- Weather station.

2.11. Grid Connection Works

The Contractor shall be responsible for the design, installation and testing of the Works required to achieve grid connection of the Plant in accordance with the requirements of the Related Documents and all applicable Law and Authorisations. These works are split by eventual ownership thereof into the Facility Connection Works, and the Eskom and NTCSA Connection Works.

The Employer shall act as the counterparty to the Connection and use of System Agreement. For the avoidance of doubt, the Contractor shall provide all assistance reasonably requested by the Employer, as may be necessary to ensure that that connection occurs in line with the Programme and requirements of the CUOSA.

The Contractor shall provide all reactive power compensation equipment and/or harmonic filters required as applicable to obtain Grid Code compliance as part of the Contract Price.

2.11.1. Facility Connection Works

The Facility connection works shall comprise of the following:

- MV cable collection system (33 kV) capable of bypassing individual inverter stations;
 - Bidder to select MV voltage level based on their proposed design.
- Backup generator and dedicated LV-MV step-up transformer (suitable for continuous operation of the facilities critical loads during grid outages) connected via an automatic change-over switch to the LV board of the substation;
- MV-HV (132 kV) step-up substation at the Project Site, comprising:
 - 4x 140 MVA 33/132 kV transformers;
 - 132 kV Transformer Feeder Bays (including Isolator, Earth Switch, Surge Arrestors, CTs, VTs and Breaker);
 - 1x NECRT per transformer with auxiliary supply;
 - 20x Indoor MV switchgear with bus section and filter bank breakers as applicable;
- Bunds encompassing MV/HV transformers and NECRTs draining to an underground oil dam equipped with an oil-water separation mechanism;
- All associated protection, control, telecoms, AC/DC, and metering systems;
- 1x Control building (Relay Room and Switchgear Room);
- Set of Lightning Masts;
- Security System;
- Internal gates and fences; and,
- Space for harmonic filters and reactive compensation equipment.

2.11.2. Eskom and NTCSA Connection Works

2.11.2.1 *Distribution Connection Works*

The Eskom distribution connection works shall be as detailed in the Distribution Self-Build Agreement, including:

- Construction of the new 2x bay (1x line feeder bay, and 1x IPP metering bay), 132kV single busbar Masego collector substation (with spatial allowance for a future single bus-section, and 1x 132kV line feeder bay).
- Construction of a Single Circuit Twin Bersfort 132kV line (~16km) from the new NTCSA Artemis MTS to the Masego collector substation.

2.11.2.2 *Transmission Connection Works*

The NTCSA transmission connection works shall be as detailed in the Transmission Self-Build Agreement, including:

- Establish the new 400/132/22 kV Artemis Main Transmission Substation ('**MTS**') including all associated secondary plant
 - Establish 400 kV yard (Breaker and a half)
 - Establish and equip 2 x 400 kV feeder bays (Loop-In Loop-Out ('**LILLO**')) of the 400 kV Beta Perseus 2 Overhead Line ('**OHL**'))
 - Install and equip 1x 400kV transformer bay (500 MVA)
 - Provide space for 1x spare and 2x future 500MVA 400/132 kV transformers
 - Establish 132 kV yard (double busbar)
 - Establish and equip 1x 132 kV feeder bays
 - Establish and equip 1x 132 kV bus-coupler bay
 - Spatial planning to cater for:
 - 2x future 400 kV feeder bays
 - 1x spare and 2x future transformer bays
 - 400 kV busbar reactor
 - 4x spare & 5x future 132 kV feeder bays
 - 132 kV fault current limiting reactors (series with TRFR)
- Loop-in and loop-out to existing NTCSA Beta - Perseus 2 400kV overhead line via 2 x 750m Twin Dinosaur 400kV line turn-ins into Artemis Substation.
- Remote End work at the existing Perseus MTS and Beta MTS:
 - De-commission line traps and replace with PIs
 - Relabelling of the 400kV existing Beta 2 (FDR 2) / Perseus 2 (FDR 3) feeder bays (including all equipment)
 - Modify 400 kV protection schemes to differential protection over fibre for both Main 1 and Main 2 protection on the new Artemis-Beta and Artemis-Perseus 400 kV feeders
 - Replace existing 2x shield wires on Beta-Perseus 2 400 kV line with 2x OPGWs. 2x OPGWs to be installed on new LILLO to match the 2x OPGWs on Beta-Perseus 2.

All relevant NTCSA standards and specifications will be adhered to in the design, construction, commissioning, and handover of the MTS and related works.

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The above details are indicative of the scope of the Self-Build Agreement works as at signature date. Any changes to the above scope shall be handled in line with the provisions of the Contract in terms of pass-through principle.

2.12. Parts and Tools

The Contractor shall provide at its own cost all consumables, goods, Materials and Spare Parts necessary for discharging its responsibilities under the Contract, including commissioning, and during the Defects Notification Period.

The Contractor shall have an ongoing obligation to implement a system to track consumables, goods, Materials and Spare Parts (itemised) that have been ordered, shipped to, delivered to, installed and commissioned at the Site. The Employer shall have the right at any time to undertake audits and verification of the Contractor's Materials tracking system. The Contractor's tracking system shall comprehensively provide the list of, where relevant, the following:

- A unique identification number (manufacturer's serial or stock number);
- Item description;
- The part of the Facility the item is associated with;
- Recommended quantities;
- Cost per item;
- Country of origin / supply;
- Identity of manufacturer;
- Identity of supplier;
- Anticipated procurement lead-times;
- Special / abnormal procurement (to the Site) requirements (if any);
- Storage requirements; and
- Confirmation that the item and the handling and storage at Site thereof complies with warranty / guarantee requirements.

All tools, equipment and Plant to facilitate maintenance of the Facility (including if required, module cleaning equipment) shall be provided by the Contractor and shall be included in the Contract Price. Tools are regarded as any proprietary, non-consumable equipment required for the efficient and safe operation and maintenance of the Facility. For the avoidance of doubt the tools shall be warranted and repaired or replaced for the duration of the Defects Notification Period.

The Contractor shall provide a comprehensive list of tools, equipment and Plant, indicating the following:

- A unique identification number (manufacturers serial or stock number);
- Tool description;
- Where the tool is to be utilised i.e. the specific component or equipment within the Facility;
- Quantities;
- Cost per item;
- Country of origin / supply;

- Identity of manufacturer;
- Identity of supplier;
- Anticipated procurement (to the Site) lead-times;
- Replacement intervals; and,
- Calibration requirements.

Any specialist tools necessary to perform maintenance of the Facility will be supplied by the Contractor prior to commencement of commissioning. The Contractor shall identify which tools shall be provided to the Facility.

2.13. Software

The Contractor shall design the Facility and prepare any study or evaluation using software tools and programs consistent with good industry practice.

The Contractor shall provide all software and required software licences required for the efficient and safe operation of the Facility for the duration of the Design Life, together with a list identifying:

- The identity of the licensor;
- The name of the software;
- The systems or equipment the software is associated with;
- The software update version number; and
- The method of software update.

All software installed on the Facility's equipment shall be licensed, for the current version as at the date of Completion, excluding updates, and shall be valid for a minimum of 30 years from the date of Completion. License fees that authorise updates and support for the installed software shall be timeously paid by the Contractor until the end of the Defects Notification Period.

2.14. Performance Tests and Warranties

The results of any Performance Test shall be the values recorded and calculated. Testing uncertainty shall be a measure of the quality of the test and shall not be a tolerance or additional allowance on the pass/ fail criteria.

The Contractor shall undertake, at its responsibility and cost, all factory, pre-commissioning and commissioning tests as detailed in Schedule 8 [Tests] and any other tests necessary to demonstrate the quality and reliability of the Facility.

In addition, the Contractor shall provide warranties and guarantees for the main equipment of the Facility with minimum durations as follows:

- PV module linear performance warranty – at least 25 years;
- PV Modules product warranty – 10 years;
- Inverter product warranty – 5 years;
- PV module mounting structure – structural warranty – 20 years;
- PV module mounting structure – product warranty – 5 years;

- LV/MV transformer warranty – 5 years;
- MV/HV transformer warranty – 2 years; and
- All other components – 2 years.

Other than those specific testing requirements to be completed by others as documented in the CUOSA and PPAs, the Contractor shall carry full responsibility for the testing of the Facility to the full satisfaction of the CUOSA and local Grid Code.

The Contractor shall, in consultation with the Grid Network Service Provider ('**GNSP**'), propose a full test programme in order to demonstrate compliance with the GNSP requirements, in order to achieve Completion on or before Commercial Operation.

The Contractor shall provide a provisional testing programme for Grid Connection Works within 90 Days of Notice to Proceed, and shall co-ordinate with the GNSP and Employer to ensure a final test programme is agreed at least 45 Days prior to the Facility's energisation date.

2.15. Documents

The Contractor shall prepare all required documentation and manuals whilst ensuring that they conform to relevant Standards.

The Contractor shall make available in due time such documentation to the Employer in electronic and paper form.

2.16. Training

The Contractor shall plan, manage, and conduct a training programme for the Employer's personnel and Operator. All training activities and materials shall be competently conducted in English.

The Contractor shall conduct a single training programme for up to five (5) personnel designated by the Employer and additional personnel as designated by the Operator. The training shall be conducted over a minimum of five (5) days and in line with any terms prescribed in the Contract.

The training session shall be completed at a date to be agreed with the Employer, and at the latest prior to Completion.

Training topics shall include:

- Site personnel safety;
- Emergency inverter and plant shut down procedure;
- Inverter start up procedure;
- MV and HV infrastructure operations and maintenance;
- Any requirements of the Grid Operator e.g. inter-trip schemes and how these have been accommodated in the Facility design;
- O&M manual detailed review;
- Facility operations and procedures;
- Review Site maintenance plan;

- Detailed review of as-built drawings;
- Cleaning/washing process of module surface (in case of unexpected dirt) including any particular requirements for the specific module type and installation configuration;
- Deactivation and re-activation of all alarm systems;
- Use of all keys and/or access control systems;
- Failure detection and prevention;
- Walking tour of security system;
- Simulated release of alarm and action required; and
- SCADA system demonstration including alarm/fault code identification and resetting and compilation and export of data.

A detailed training program shall be provided by the Contractor to the Employer 45 Days prior to the start of the training course. The training program shall be subject to Employer comment. Final training manuals shall be made available to participants no later than 10 Business Days in advance of the agreed commencement of the training.

3. Site Details

3.1. The Site

The Site is specified in tables and maps in this Section.

Table 2: Site description

Item	Description
Name of place	Near Dealesville
Region	Free State Province, South Africa
Location Description	Farms Welgeluk No. 1622 and Ebenhaezer No. 1623
Latitude	28°45'35.59"S
Longitude	25°38'10.45"E
Altitude (a.s.l)	1240 m
Development Area	~1000 ha
Access	Off the S322 secondary road which branches off the R64 regional road at Dealesville

Table 3: Site boundary co-ordinates

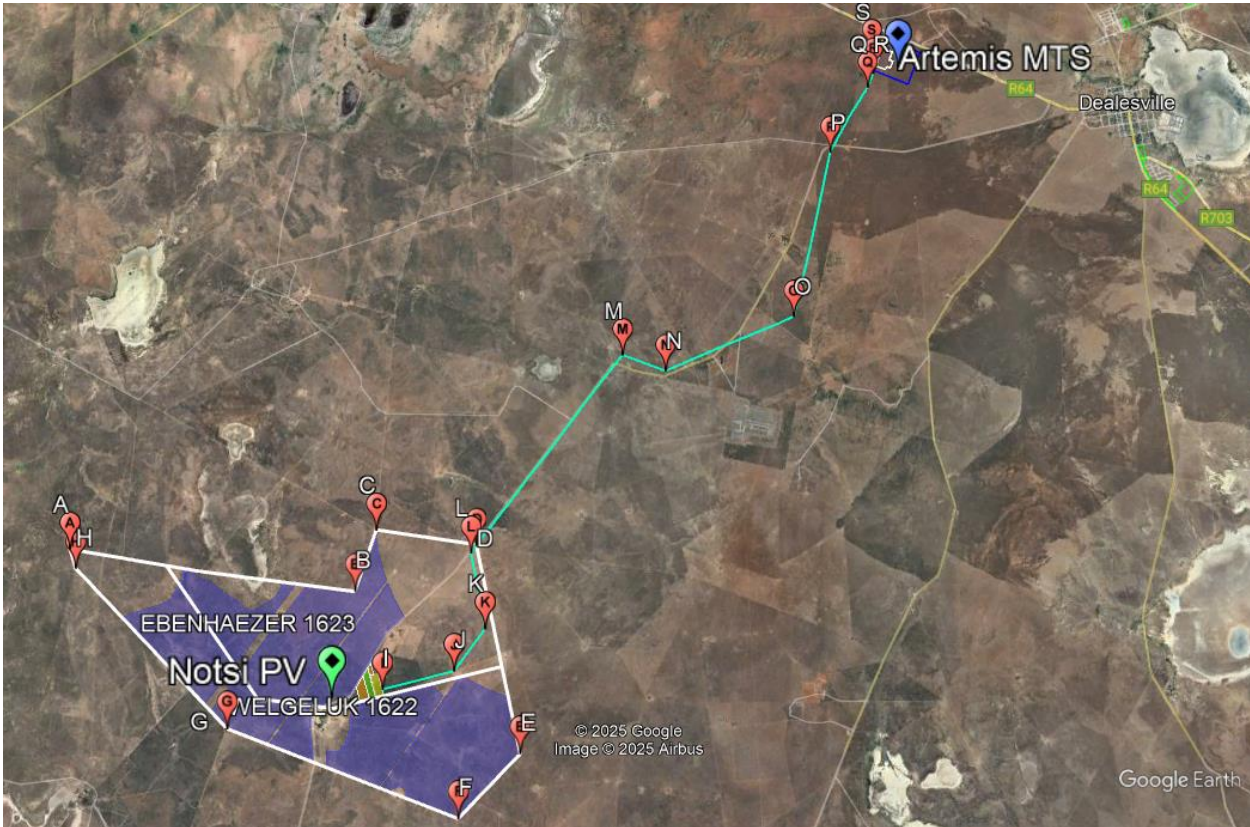
Point	Latitude	Longitude
A	28°44'21.73"S	25°35'35.73"E
B	28°44'42.68"S	25°38'22.50"E
C	28°44'12.09"S	25°38'33.94"E
D	28°44'19.86"S	25°39'32.19"E
E	28°46'03.01"S	25°39'58.88"E
F	28°46'34.41"S	25°39'24.12"E
G	28°45'51.03"S	25°37'11.16"E
H	28°44'31.42"S	25°35'39.68"E

The site shall also include the areas and routes detailed below. Note, these are approximate co-ordinates, as currently permitted, and are subject to minor changes.

Table 4: Approximate overhead lines co-ordinates

Point	Latitude	Longitude
I	28°45'31.63"S	25°38'39.58"E
J	28°45'22.51"S	25°39'20.48"E
K	28°45'01.64"S	25°39'37.97"E
L	28°44'23.67"S	25°39'29.21"E
M	28°42'41.87"S	25°40'56.92"E
N	28°42'50.22"S	25°41'22.25"E
O	28°42'21.73"S	25°42'38.28"E
P	28°40'53.95"S	25°43'01.50"E
Q	28°40'18.59"S	25°43'24.84"E
R	28°40'10.98"S	25°43'28.46"E
S	28°40'00.65"S	25°43'27.85"E

Figure 1: Map of site boundary and overhead line



Access to the Site shall be from the S322 secondary public road. The Site entrances and access roads shall be identified and assessed by the Contractor who will determine the necessary upgrades required to ensure that the S322 and access roads are adequate for the heavy and oversized vehicles which will deliver all goods and materials, including transformers, to the Site. The S322 and all access roads must be maintained for the duration of the construction phase and any required reinstatement works required must be concluded prior to Taking-Over.

The site entrance positions must be identified, designed, and submitted for approval to the relevant authority and constructed in accordance with the designs (once approved).

3.2. Site Conditions

The Contractor shall be responsible for identifying and fully detailing all relevant Site and climatic conditions applicable to the Facility, and documenting these conditions in a Site Conditions report to be submitted within four weeks of Notice to Proceed. The Contractor's assessment shall be based on its own assessment and investigation as to the most severe climatic conditions or local regulations which should be used as a basis for the final design of the Facility.

4. Project Management

Until Taking Over the Facility shall be managed solely by the Contractor.

The Contractor shall utilise its extensive project management skill, experience and resources to appoint a competent team for the successful execution of the Facility. Key project management activities of the Contractor shall include:

- Responsibility for all engineering, procurement and construction aspects of the Facility ensuring that the Contractor's individual activities are compatible with each other and with the overall Schedule and Milestone Schedule.
- Ensuring that the Facility is technically integrated and cohesive.
- Ensuring that all documentation is to a common format and style of presentation and is competently rendered in the English language.
- Applying technical control to ensure that a consistent approach is adopted by all of the Contractor's engineering teams (including Subcontractors).
- Ensuring the cohesive, accurate and timeous provision of documentation in support of review processes, construction activities, commissioning processes, testing processes - all within the timescales agreed as per the Schedule and Milestone Schedule.

4.1. Planning and coordination

The Contractor shall prepare a Project Execution Plan ('PEP') outlining how it intends to execute the Facility, and shall provide the PEP to the Employer within 30 Days of the Notice to Proceed date.

The PEP shall include all major elements of the Facility including project management and control, engineering design and technical coordination, procurement, point-of-manufacture inspection and testing, construction including pre-commissioning, commissioning and training required for the Facility. The PEP shall include an interface management plan, with detail of authority management, outlining how the Contractor will manage and coordinate interfaces among parties involved in the Work including subcontractors, equipment suppliers and the Employer.

The Contractor shall undertake as a minimum all of the following services.

- Project management, including project administration, scheduling, cost control, and Quality, Health, Safety and Environment ('QHSE') management;
- Conduct reviews and incorporate outcome of reviews such as constructability, operability, accessibility, maintainability at appropriate stages of the design process and fully document and provide reports regarding these reviews to the Employer;
- Lead and participate in design, coordination and progress meetings with the Employer (and its engineers), GNSP or any other party as required;
- Technical support for the Employer's permitting and licensing activities including compliance with all relevant requirements of the Employer's Authorisations;
- The planning and design of the Work; and
- Coordinate all work with others as required including its Subcontractors, the landowner, the Employer and the Employer's personnel, the GNSP and any other affected parties.

4.2. Procurement

The Contractor shall be responsible for the overall management of procurement, including expediting, and QA/QC with respect to all elements constituting the Facility.

The Contractor shall, in order to satisfy the requirements contained in this ERs, identify the manufacturers and places of manufacture and ensure appropriate testing and inspection of major equipment (i.e. modules, inverters, transformers, trackers including mounting structures, drives, controls etc.) and switchgear before dispatch to Site.

Where major equipment is yet to be manufactured the Contractor must promptly alert the Employer accordingly, supplying the anticipated manufacture dates so that the Employer may (at its sole discretion) inspect the point of manufacture prior to manufacturing beginning.

Unpriced copies of purchase orders shall be expeditiously provided to the Employer if requested.

4.3. Construction Management

The Contractor shall be responsible for the overall management of the Facility and operation and maintenance until Completion. These services include but are not limited to:

- Management of the Contractor's staff and its Subcontractors;
- The provision of suitable and adequate security for the Site for the duration of the construction period and until Completion;
- Conducting risk assessment and implementing resulting mitigations for all activities related to the Works;
- Provision of construction power, water, fire protection, lighting, compressed air, telephone, data transmission and sanitary facilities;
- Construction of all necessary access roads and roads on Site and reinstatement of existing roads after the construction, if required;
- Provision of all required tools, components, machinery, and test equipment;
- The positioning of the component parts forming part of the Facility, such that they can be operated and maintained in a safe manner wherever possible without requiring specialist Third Party equipment to access, operate, maintain, exchange, or replace. For example, inverters should be placed in an easily and safely accessible area;
- The supply and transportation of all components constituting the Facility to the Site and to the specific installation locations;
- Transportation, handling and installation methodology of all components which is in line with manufacturers' recommendations and which does not compromise the integrity or warranties of any components;
- Equipment and materials-receiving, handling, laydown areas and storage (indoor and outdoor as required). No additional land will be provided by the Employer for laydown beyond the boundaries of the Site;
- The construction and foundation of all supporting or mounting structures as necessary;
- The assembly and installation of the components;
- The installation of an approved energy meter and associated communication equipment;

- The registration of the Facility with any applicable authorities, industry bodies, etc;
- The design, installation and integration of the Facility earthing and bonding systems;
- The design, installation and integration of the Facility Lightning Protection Systems; and,
- Coordination and cooperation with the party responsible for the Grid Connection Works to facilitate the connection of the Works to the Grid in accordance with the requirements of the GNSP and the CUOSA and PPAs.

4.4. Progress Reporting and Meetings

The Contractor shall produce weekly and monthly progress reports, at dates to be agreed with the Employer. Reporting format and contents are to be agreed by the parties within 30 days of NTP.

The Contractor shall attend monthly site meetings along with any other meetings necessary to complete the Works or reasonably required by the Employer.

5. Quality Assurance / Quality Control

The Contractor shall be responsible for implementing its Quality Plan, including, but not limited to design, construction, transportation, storage, installation, materials, equipment, checkout, start-up and operation until the Contractor has discharged its obligations in terms of the Contract.

The Quality Plan shall be enforced to assure that the Works are conforming to the Contract requirements and shall include as a minimum:

- Contractor's quality policy;
- Qualifying material vendors in line with the technical specification;
- PV module manufacturer flash test data;
- PV module factory inspection and additional testing as required;
- PV module factory quality acceptance standard;
- On site material inspections;
- Factory expediting and testing;
- Employer's hold and witness points;
- Material acceptance tests when required (concrete, steel, specific components, etc.);
- Field quality inspections;
- Field testing documentation;
- Coverage of electrical works;
- Documentation of all changes to drawings and specifications;
- Full Inspection and Test Plan for the Works; and,
- Defects, deficiencies, non-conformance's and punch list items.

The Contractor shall develop and maintain a record of defects, deficiencies and non-conformances identified during construction, which shall be included in weekly progress reports.

The rejection criteria for major equipment delivered to the Site shall be equivalent to the factory-leaving acceptance criteria.

5.1. Factory Acceptance Tests

All goods, Materials and other items forming part of the Facility shall be tested in accordance with Law, Authorisations, Standards and the Quality Plan. Quality checklists and test protocols shall be submitted to the Employer prior to factory tests.

Further requirements for Factory Acceptance Tests are contained in Schedule 8 [Tests].

5.2. Inspection and Test Plan

The Contractor shall submit an Inspection and Test Plan ('ITP') covering the whole of the Works within 60 days of Notice to Proceed. The Inspection and Test Plan means a document detailing all inspections and tests to be performed by the Contractor, Third Party auditors and the Employer, in order to ensure that the Facility is completed in line with requirements of the Contract. The Inspection and Test Plan will include an overview of all tests to be performed, along with detailed test sheets which will be completed during each test or inspection. All test sheets will be provided

to the Employer once relevant tests are completed. The ITP shall be provided in order that the Employer can confirm all tests are being performed to Contract requirements, and attend relevant tests.

Further ITP requirements are contained in Section Schedule 8 [*Tests*].

6. Health and Safety Plan

The Contractor's Health and Safety Plan shall document which relevant and current Health and Safety Law and requirements the Facility falls under, and will describe how the Contractor will ensure the Works are completed in line with such Law, requirements and good industry practise.

The Health and Safety Plan shall include a Health and Safety policy defining the Contractor's commitment to Health and Safety matters to the satisfaction of the Employer.

The Contractor acknowledges is responsible for:

- Promoting and maintain a safe working environment, implementing the requirements of Schedule 18 [*Health and Safety Specification*] in the Contractor's QHSE policies;
- Management and control of all Works carried out on the Site and the supervision of all employees and Subcontractors on the Site;
- The safety of all personnel on the Site;
- Management and regular review and updating of all Health and Safety documentation, including sub-contractor risk assessments and method statements;
- Provision of all personal protective equipment and clothing required to comply with all Health and Safety legislation;
- Providing induction and appropriate training of all personnel attending site and maintain appropriate records;
- Immediate notification (to the Employer and relevant authorities as applicable), investigation and reporting of all incidents that caused or could have caused injury to personnel or caused damage to equipment or structures on the Site;
- Provision of first aid facilities and trained first aid personnel on the site at all times that work is being carried out including the provision of a site ambulance and qualified paramedics; and
- Developing, tracking and review of Health and Safety key performance indicators.

6.1. Incident Reporting

The Contractor must notify the Employer, and any other parties nominated by the Employer, of any incident involving injury, property damage or environmental damage, any near misses and all hazardous observations. The incident reporting procedure shall be defined in the Health and Safety Plan. Incidents must be investigated within seven days and lessons learned reported to the Employer.

The Contractor must ensure that all reportable incidents are reported to the relevant authorities immediately or as required by Law.

6.2. Hazardous Areas

Areas where a potential flammable atmosphere may exist shall be classified to the relevant sections of Law, Authorisations, and Standards.

Only suitably certified equipment shall be kept or used in designated hazardous areas. To the maximum extent practicable, equipment requiring operator attention and/or electrical equipment shall not be installed in hazardous areas.

6.3. Fire Protection and Fire Fighting Systems

The fire alarm and detection, fire protection and firefighting systems shall accord with recognised good practice and shall comply to all applicable Law, Authorisations, and Standards.

The Facility shall be designed, installed and commissioned so as to ensure a safe operating environment for equipment and personnel. This shall be achieved through the separation and segregation of equipment with sufficient distances and by selection of suitable equipment and materials with respect to their intended purpose. A reasonable degree of self-sufficiency shall be designed for taking into account the location of the nearest fire department or formally constituted and adequately maintained and resourced fire-response cooperative, shall be designed for.

For the protection of personnel and the Works the Contractor shall ensure adequate on-site fire-fighting facilities and water storage are available on the Site. The Contractor shall liaise with local authorities so as to inform themselves of requirements, capability, fire prevention practices and in order to determine the scope of the facilities to be provided.

Notwithstanding the requirements outlined above the Contractor shall:

- Conduct a Fire Risk Assessment in accordance with Best Industry Practice and applicable to both construction and operation of the Works;
- Design, plan, construct, test, commission and operate the Works in such a way as to minimise the fire risk of the Work;
- Ensure that the Site and Work is suitably equipped to respond to any fires on Site;
- Notify the relevant local emergency management committee following construction of the Works, and prior to the commencement of operations; and,
- The Emergency Response Plan shall identify fire risks and controls, and procedures that would be implemented if there is a fire on site or in the vicinity of the site.

7. Environmental Plan

The Environmental Plan shall document how the Contractor will ensure compliance with all statutory obligations, including Law, legislation, and requirements of Employer's Authorisations and Contractor's Authorisations. The Contractor shall, to the greatest extent possible, complete the Work to minimise disruption and damage to the environmentally conscious and minimise where possible the impact of the Facility on the environment. The Contractor shall comply with the Employer's social responsibility requirements during the completion of the Work.

8. Design Requirements

8.1. General

The Facility shall be designed for a minimum of 30 years' continuous performance of its intended function with respect to Site Conditions and anticipated operating conditions (including but not limited to lightning prevalence and severity, ambient temperature, soil, flooding, dust and mud, irradiation, grid conditions, and altitude) based on regular scheduled maintenance being performed.

The designs, components and materials to be used by the Contractor shall be of proven quality and shall have been used in international non-recourse project-financed projects. The Facility design shall consider future safe and economical decommissioning and Site rehabilitation without undue harm to the environment.

The systems shall be designed and optimised in such a way as to minimise the losses due to shading, soiling, DC & AC cable losses, inverter losses, mismatch and transformer losses. In particular:

- The array cabling network must be designed to ensure that the total cable losses (DC & AC) are less than 2% in average for the total array cabling network at STC conditions;
- The MV/HV Transformer Losses must be less than 0.75% for annualised electrical losses in average as a percentage of total input energy;
- The LV/MV transformers shall not contribute more than 1.1% annualised electrical losses in average as a percentage of total input generated energy;
- The calculation of electrical losses shall consider the expected irradiance for the Facility; and
- The loss calculation shall include all assumptions made and be provided to the Employer for review.

Auxiliary loads shall be kept to a minimum, particularly during non-generation periods.

The Facility shall be designed such that normal operation of the Facility shall not create risks to operations or maintenance personnel. The Facility shall incorporate all QHSE elements required and in accordance with good industry practice, including, if required hazard identification sessions.

8.2. Design Review by Employer

During the course of engineering, procurement, and construction of the Facility, the Contractor shall submit design documentation for review by the Employer.

The Contractor shall produce an explicit and exhaustive list of all design documentation to be produced within 30 Days of Notice to Proceed.

The Contractor shall maintain a document management system and tracker sufficient to identify status and revision numbers associated with the document.

As part of the design packages the Contractor shall submit detailed design reports including specifications and drawings to the Employer for review, comment and approval. The scope for the design report shall cover design input, design output, design reviews, design verification and design validation to ensure compliance with the Contract. The Contractor shall provide the Employer with not less than five (5) Business Days' notice in advance of submitting the relevant design package. The Employer shall review the design package and provide comment within 15 Business Days.

The Contractor is to ensure that all documentation submitted to the Employer is complete and has been subject to the Contractor's review and approval process as documented in its Quality Plan.

All comments made by the Employer are to be addressed by the Contractor to the satisfaction of the Employer and relevant documents or drawings shall be re-submitted so that the Employer may assess the adequacy of the revised submissions. For the avoidance of doubt the Employer's right to comment on design documentation does not transfer any responsibility to the Employer, and the Contractor shall ensure the Facility is designed in line with requirements of the Contract.

Documents and designs shall be submitted electronically in both editable (native) and PDF formats. Drawings shall be provided in an editable AutoCAD DWG or DXF format so as to enable reproduction of drawings and PDF, unless otherwise agreed in writing.

All drawings shall be unique to the Facility and not typical or indicative.

8.3. Civil and Structural Works

The Contractor shall be responsible for all ground risk in accordance with the Contract including the design and construction of foundations, drainage, and subsurface works suitable for the actual geotechnical conditions of the Site.

8.3.1. General Characteristics

Civil works shall include but not be limited to the following items:

- Site investigations and surveys;
- Conservation and re-use of topsoil;
- The establishment and upgrade of all necessary access roads to construct, operate and maintain the Facility, including permanent access to the Facility;
- The establishment of a 5m wide fire-break both outside and inside of the Facility fence (10m in total excluding internal perimeter roads);
- Site preparation: site clearance, earthworks, excavations, fillings, and levelling;
- Foundation and structural systems;
- General buildings and all electrical and mechanical buildings;
- Furnishing and equipping of all buildings required for operation and maintenance of solar farm (e.g. tables, chairs, cupboards, storage racking etc.);
- Storm-water drainage systems;
- Sewers and sewage systems;

- Water supply and storage;
- Road crossings and directional drilling as required;
- Electrical and earthing trenches;
- Ducts and ducting;
- Parking lots, storage areas;
- Fencing, gating and access control;
- Landscaping and establishment of appropriate low-maintenance groundcover;
- Any further civil works arising out of the Environmental Authorisations or Environmental Management Plan;
- Maintenance until Completion is achieved;
- Rectification of defects;
- Temporary buildings (e.g., offices for the Contractor);
- Temporary roads and parking and laydown and storage areas;
- Temporary fencing, lighting and security for all materials;
- Reinstatement of access roads outside the Site area; and,
- Reinstatement, and where appropriate, rehabilitation of the Site.

Any temporary work shall be promptly removed by the Contractor before Completion or upgraded to meet requirements for permanent civil works as part of the scope of works.

8.3.2. Access Roads, Parking Areas, and Other Areas

Internal roads, parking areas, and other surfaces within the Site shall be the responsibility of the Contractor.

Internal roads shall be planned and constructed according to the Facility configuration proposed by the Contractor and shall be adequate and suitable for the operation and maintenance activities that will be required for the design life of the Facility.

All surfaces shall be designed to allow proper drainage. The drainage system will be designed such that water drains away from key components following periods of rainfall. The drainage system shall be designed in a manner such that other infrastructure (such as trenches, ducts or cable conduits) do not act as part of the drainage system.

Surfaces shall be designed to support the use of heavy vehicles needed for the transportation of goods and Materials to and within the Site during the construction and operations phases of the Facility. Heavy vehicle loading shall be analysed based on a Facility specific analysis of vehicle movements over the construction and operations phases. Roads and parking areas shall be designed to suit Site Conditions and the findings of the Geotechnical Report. Compacted crushed rock shall be used as a construction material.

All buildings and surfaces to receive equipment shall be designed with appropriate specifications to manage flood risk, including height above ground level. If required, a flood risk assessment shall be produced to confirm flood resistant design criteria are appropriate.

Roads and surfaces shall be designed in conformity with a specialist geotechnical report procured by the Contractor. When compliant with the structural requirements, locally available material shall

be used. Road surfacing shall mitigate against potential module damage or soiling caused by traffic. Roads shall provide easy access to all the SCADA boxes, tracker drives, inverters, transformers, substation, and permanent buildings, located within the Site.

Roads width (the usable surface) shall be at least 4 metres for internal roads and 6 meters for main site access road, or as per relevant local requirements. The turning radius shall be sufficient to allow access for maintenance and replacement of the largest components and for emergency personnel.

Dust control measures are to be implemented during construction as well as permanent measures at the end of construction to minimise dust during operation and maintenance activities.

Parking and storage areas sufficient for operation and maintenance of the Facility shall be foreseen and provided.

8.3.3. Foundations

Prior to construction the Contractor shall carry out all necessary geological and geotechnical investigations and studies so as to satisfy itself of the ground conditions.

In the Contractor's calculation notes and drawings, the following information, as a minimum, shall be made available to the Employer:

- Detailed foundations characteristics (type, dimensions);
- Reinforcement characteristics (diameter, steel grade, protection against corrosion);
- Concrete characteristics (grade, composition); and
- Static and (if applicable) dynamic calculations.

Foundation surfaces shall be carefully finished, and all concrete works shall be floated and have bevelled edges.

8.3.3.1. *Foundations for PV Arrays*

The Contractor shall design the foundations according to tracker manufacturer requirements.

The Contractor shall provide a detailed structural analysis demonstrating that the design conforms to Contract requirements and shall clearly state in its report the load assumptions, design specifications and design life.

In designing the foundations, the Contractor shall take into account all loads from the upper structures. The foundations and sub-structures shall be able to transfer all actual load combinations, including horizontal and uplift forces, safely to the foundation system with an appropriate factor of safety. The Contractor shall state in its calculations the maximum permissible foundation movement that may be tolerated consistent with normal operation of the Facility. The Contractor shall provide foundation design documentation to the tracker supplier for review and comment, and shall make the comments of the tracker supplier available for Employer review.

8.3.3.2. *Other Foundations*

The Contractor shall provide a detailed structural analysis demonstrating that the design conforms to the Contract and shall clearly state in the report the load assumptions and the design specifications. Foundations shall be designed to withstand the Site Conditions for the entire lifetime of the Facility, without being replaced.

In designing the foundations, the Contractor shall take into account the loads the foundation will be subjected to. The foundations shall be able to transfer all actual load combinations, including horizontal and uplift forces, safely to the foundation system with a suitable factor of safety.

Platforms for oil-filled step-up transformers shall include an oil spill containment basin and shall allow for oil-water separation. Bunding shall be provided for 110% of the full volume of oil contained in the equipment placed on the foundation or be designed as required by local regulations.

8.3.4. Structural Design Principles

All design reports, calculations and drawings prepared by the Contractor shall be signed by a professional structural engineer as being appropriate.

Dynamic loads shall be considered when these might lead to higher stresses than static loads, and these shall be estimated using state-of-art tools and methodologies. A modal analysis shall be performed when necessary.

Fatigue verification shall be performed should fatigue be considered as critical for the component under evaluation. Estimations shall be performed using state-of-art tools and methodologies.

8.3.5. Load Assumptions

In designing the Facility, the Contractor shall take into account all the reasonably expected loads that the Facility might be subject to, including, but not limited to:

- Self-weight loads;
- Transportation and handling loads;
- Construction loads;
- Wind loads;
- Thermal loads;
- Seismic loads;
- Snow loads, and
- Water (flooding) loads.

The Contractor shall consider the loads and load combinations as applicable to the Site. The Contractor is responsible for system survivability over the design life of the Facility.

8.3.5.1. *Wind Loads*

The Contractor shall verify the suitability of the structures and components for the Site Conditions and shall document the assumptions made.

Each component forming part of the Facility shall be designed or verified for the expected wind loads. This includes, but is not limited to, foundations, buildings, PV modules, support and mounting systems, tracking systems, towers, weather stations, fences etc.

The Contractor shall perform its own investigation as to the maximum expected wind conditions over a return period, in any case not less than 50 years.

Wind induced vortex shedding shall be taken into account and checked against the frequencies of the structure. Wind-induced dynamic instability shall be avoided.

In the case of trackers, deformation and twisting of the structures shall be considered whenever it leads to higher loads at the structure. Furthermore, also in the case of trackers, the structure in stow position shall be verified considering a difference from ideal stowing angle of at least $\pm 2^\circ$ to account for imperfect alignment.

Wind loads shall be duly combined with other loads by implementing adequate safety factors.

The Contractor shall seek to support its assumptions and calculations using wind load tests, such as wind tunnel tests or computational fluid dynamics tests whenever necessary to demonstrate compliance with the Contract.

8.3.5.2. Seismic Loads

The Contractor shall perform its own investigation as to the maximum expected seismic accelerations over a return period compatible with the design life and use of the Facility.

The Contractor shall duly document the assumptions made using available measurements and any supporting material verifying the suitability of the structures and components to the Site Conditions. Each component forming part of the Facility shall be designed or verified against the expected seismic loads.

Seismic loads shall be combined with other loads by implementing adequate safety factors.

8.3.6. Civil Construction Material

Materials selected by the Contractor shall be proven to be suitable and sufficient for the Facility design life. In particular, structural steel will be procured in line with all applicable Laws and standards, and concrete testing shall be performed in line with local requirements.

8.4. HVAC Works

HVAC works shall be designed in accordance with the requirements of equipment manufacturers and the Contract, accounting for local ambient conditions over the Facility design life.

8.5. Electrical Works

All electrical equipment shall bear nameplates according to international and country-specific requirements. All materials shall be of high quality, and shall be supplied by leading manufacturers that are capable of providing material in accordance with international good practice. Special care

shall be taken to choose equipment that is backed by reliable support and maintenance in South Africa.

Protection studies are to be carried out to address the following and shall establish suitable relay settings, as necessary, including:

- Overcurrent and earth fault relay co-ordination with grading curves;
- Overload protection;
- Differential and restricted earth fault protection;
- Bus bar protection;
- Over-voltage, under-voltage protection;
- Over-frequency, under-frequency protection; and,
- Anti-islanding protection.

Protection studies and system studies shall cover all equipment and systems including but not limited to modules, combiner boxes, inverters, MV system including switchgear and cabling, all auxiliary systems, DC systems, UPS systems, earthing and bonding systems, lightning protection systems, building services, and connection compliance equipment (if required), etc.

All medium voltage and low voltage switchgear, DC equipment and AC equipment shall be designed with respect to the Site Conditions and shall be equipped to withstand high amounts of dust in the air.

The electrical system shall be controlled and monitored through the SCADA System.

The Facility is to be equipped with a low-voltage system for powering:

- Buildings and Support Facilities;
- Lighting;
- SCADA System;
- Security system; and,
- Meteorological stations.

All electrical installations are to be installed in a neat manner in order to facilitate access during operations, and ease troubleshooting and maintenance activities.

The Contractor is responsible for the supply, installation and termination of a complete electrical system and the facility must be designed in such a way as to include the following:

- Meet the requirements of the CUOSA;
- Passive and active inverter anti-islanding protection built into each inverter;
- Independent backup power for protection devices;
- Trip circuit continuity, monitoring and fail alarming;
- All equipment shall be rated for full load and the maximum prospective fault current levels;
- Co-ordination with upstream protection (including the GNSP protection systems);
- Auto-restarting of the inverters following interruption of grid supply, where permitted;
- Earthing for substations, inverters, array and array frames, fences and other structures as required;

- Employer's SCADA requirements;
- GNSP SCADA requirements;
- Inter-trips signals from the GNSP;
- GNSP revenue metering;
- Facility auxiliaries supply including auxiliary transformers, MV switchgear, LV switchgear, MV/LV bus ducts and cables, DC and UPS systems, lighting;
- Remote monitoring system of the PV system;
- Electrical building services to all buildings;
- Security and surveillance systems and equipment;
- Access control system; and,
- Site lighting.

9. Equipment and System Requirements

9.1. General

All components and equipment provided shall be suitable for installation at the Site. The Contractor will bear responsibility for assessing and accommodating for the Site Conditions.

The Facility equipment shall be designed, transported, stored, and installed or constructed in compliance with all component manufacturer installation guidelines ensuring that all warranties and guarantees are maintained intact. The Contractor shall, during the execution of the Facility, adequately protect all equipment and materials against exposure to adverse environmental conditions.

Major equipment components (not limited to PV modules, inverters and mounting structures) shall be of high market standard and proven technology (at least 18 months of operational track record), being a technology/product that has been installed (included tested, commissioned and operated) at international non-recourse project financed projects of similar size and complexity to the Facility.

Robust and clearly visible signage shall be installed as is required by the local regulation.

9.2. Labelling

All labels must be clear, easily visible, constructed and affixed to last and remain legible for the life of the Facility and shall, at least, report the following:

- Name of manufacturer;
- Product name and serial number;
- Key technical parameters;
- Manufacturing date and place; and
- Protection index (where applicable).

Major equipment components, PV array sections and all electric cables and circuits within the Facility shall be labelled to identify their location and function. this shall include at least the following.

- PV array row numbering;
- String numbering;
- DC combiner box numbering;
- DC/AC conversion blocks numbering;
- Major components including all inverters, transformers, switchgears;
- Tracking motor / tracking unit numbering;
- All electrical circuits including DC string numbering; and
- All required electrical safety labels and signage in line with good industry practice to identify live equipment.

Labelling and numbering systems must be aligned with Facility as-built documentation.

Any components not in compliance to the above requirements must be agreed between the Parties prior to installation.

9.3. Modules

The PV module must be a monocrystalline, bifacial solar photovoltaic module comprised of a number of cells (at least 132) internally connected in parallel strings of cells in series to produce a nominal power (at STC) of 550 W or more and includes the associated junction boxes and cable leads fitted at the factory.

PV modules will be rated for operation at voltage of up to 1,500 V_{DC}. PV modules shall be supplied by the Contractor based on a common bill of materials and fabrication process. The final PV module selection is as recorded in Schedule 24 [*Contractor's Technical Offer*].

All modules to be supplied will have at least a 25-year, insurance-backed linear power output warranty, governed by South African law. Such module warranty insurance will survive the insolvency of the module supplier and be valid for the warranty period. All modules procured by the Contractor, will be registered with the applicable insurance scheme in order to ensure the validity of the insurance over the 25-year (or above) warranty period. Proof thereof will be provided when the modules are delivered to site.

The PV modules shall have valid certifications according to relevant IEC and other standards. As part of the Inspection and Test Plan the Contractor will include evidence to demonstrate the bill of materials is consistent with that which was certified.

- Construction material: Monocrystalline silicon cells;
- Cell Type: P-Type or N-Type;
- Module peak power output ≥ 550 Wp at STC;
- Bifaciality: At least 70% $\pm 5\%$
- The module shall have a positive initial power tolerance (e.g. 0 to +3%);
- Monocrystalline silicon module efficiency shall be not less than 20% at STC. Module efficiency is defined as the ratio of the module output power to the intensity of incident solar radiation perpendicular to the surface of the PV module including the frame;
- Module efficiency measured during the factory flash test at an irradiation of 200 W/m² will be 96% or higher of the efficiency under STC;
- The fill factor (Nominal power divided by the product of the open circuit voltage and short circuit current) of the modules must be at least 0.7;
- The rear junction box (connection box) of monocrystalline-silicon modules shall include at least 3 by-pass diodes to protect against partial shading and module overheating. Modules must have flying leads fitted with at least IP67 rated pin type Multi-Contact ('MC') connectors or equivalent with a clear indication of polarity for the connections;
- Factory fitted module cables shall be long enough to allow the modules to be interconnected electrically in series to form strings without the need for additional cables between modules in a string (for avoidance of doubt additional cable is expected to connect a string of modules to the DC combiner box);

- The PV modules shall be capable of operating under extreme temperature (-40°C to +85°C) and humidity (5% to 95%) conditions and will be designed to ensure the highest possible reliability in operation and to ensure minimum and efficient required maintenance over the lifetime of the system. Modules shall operate at the Site Conditions;
- Each module shall permanently display a technical characteristics nameplate carrying the following information as a minimum;
- Name of manufacturer (or monogram or symbol);
- Type or model number;
- Serial number;
- Polarity of terminals or leads (colour coding is permissible);
- Max system voltage;
- Safety class;
- Application class;
- For class A modules the safety class II symbol;
- Date and place of manufacture on label or traceable from serial number;
- Specifications for each PV module shall also be provided at either Nominal Operating Cell Temperature or Nominal Module Operating Temperature indicating module characteristics under non-STC conditions;
- The percentage power loss as a function of temperature (maximum power temperature coefficient) shall not exceed 0.30% per °C away from STC;
- Flash test will be provided at STC for all PV modules, and at 25°C for a minimum of four different levels of irradiance between 200 W/m² and 1000 W/m² for one PV module per batch;
- The solar cells within the PV module shall be protected from mechanical stress and moisture via encapsulation in a plastic material of high clarity that is sufficiently flexible to allow contractions and expansions. This material shall be free of bubbles and cracks. The front and back surface of the encapsulation of the photovoltaic modules shall be protected with tempered glass of low iron content and may have a manufacturer-applied anti-reflective coating. The glass cover shall be at least 2mm thick and have strong resistance to heavy shocks, thermal stress and high wind loads including wind with high content of particulates;
- The PV module must be certified for resistance to a suction pressure of 2,400 and an increased distributed mechanical load of 5,400 Pa on the front glass surface (wind, snow and ice);
- The PV laminate (glass / encapsulant + solar cells / rear side) may be surrounded with a metal frame made of stainless steel or aluminium alloy;
- The frame shall be placed to protect the edges of the glass cover of the PV module and to facilitate support and mounting;
- The construction of the frame of each PV module shall be adequate to allow for thermal contractions and expansions of the glass cover of the PV module;
- To avoid galvanic corrosion due to electrolytic action between different materials, any contact between different metals in the PV module frame must be fully electrically isolated; and,
- PV modules must comply to IEC 61215-1 requirements and shall be tested as per IEC 61215-2, which includes testing for hail resistance as per IEC 61215-2 test MQT 17.

The active electrical components within each PV module shall be electrically insulated from the metal casing (frame) if used, any mounting structure components, the rear cover and the front glass surface. The insulation must withstand the DC voltage applicable to the module (1,500 V_{DC}) between the short-circuited module output leads and the metal frame and the rear and front covers. The insulation resistance shall be tested as per IEC 61215-1:2016 test MQT 3 and any applicable local regulation.

The factory-leaving acceptance criteria of the module manufacturer shall be provided to the Employer for approval prior to any modules being dispatched from the factory. The site rejection criteria for modules delivered to Site shall be equivalent to the factory-leaving acceptance criteria. Specifically, modules containing dendritic micro-cracks shall be regarded as defective.

Modules must be handled carefully during the transportation and construction activities to avoid unnecessary additional micro-crack damage to the modules. Additionally, a module handling plan, covering all aspects of packing, transportation, reception on site, storage and installation is to be provided by the Contractor prior to manufacturing.

Modules must be installed in accordance with the module installation manuals.

The module string configuration must be compatible with the system's maximum operating voltage and temperatures as low as the minimum recorded site temperature. Formal written and duly signed confirmation of suitability of the design from all component manufacturer's whose components will be exposed to string voltages (i.e. modules, inverters, DC cables, combiner boxes, SCADA and monitoring systems, etc.) shall be provided.

The modules shall be sorted and connected in strings based on their flash test IMP currents in order to decrease the mismatching losses.

The module string configuration must be designed to minimise losses due to minimum inverter input voltage and maximum power point tracking voltage windows at module temperatures ranging from 0°C to 75°C.

9.3.1. Module Defects

Should any module display signs of any of the following issues, the module will be deemed to be defective:

- Major cracks;
- Discolouration of cells;
- Water ingress;
- Cell micro-cracks/snail trails – as per factory acceptance tests and as a maximum 8% of the cells per module or if dendritic or if the crack electrically isolates 5% of one cell;
- EVA or backsheet delamination;
- Backsheet punctures/rips;
- Metal corrosion or cracking/ broken interconnects;
- Potential Induced Degradation ('PID');
- Glass breakage or delamination;
- Hot spots (Delta T > 10°C at 1,000W/m²);

- Junction box failure including adhesion/sealant failure;
- Frame sealant gaps;
- Cell mismatch causing the operation of the bypass diodes or affecting the output characteristic of the module (as evidenced in a stepped or otherwise affected IV-curve etc.); and,
- Bypass diode defects and/or failure.

The list presented above is not exhaustive.

9.4. Inverters

The inverters may be either central or string inverters and shall be rated to maximum DC input voltage of 1,500 V. The final choice of use of string or central inverter, and of DC voltage level, will be subject to Employer approval. Inverters will meet the following minimum requirements:

- String inverters shall be at least IP65 rated, and shall be capable of being mounted such that they are installed under the PV module arrays or specially constructed shades to provide protection from precipitation and prevent exposure to direct sunlight;
- Central inverters shall be installed in pre-fabricated lockable substations or in an outdoor installation. Electronics shall be protected with weather-proof material to at least IP54 protection degree and protected against corrosion and any other natural elements. The inverter manufacturer shall confirm the suitability of the inverter station, taking into account the Site Conditions;
- The inverters shall have proven track records in terms of performance, operation, and obtaining long term debt (international project finance);
- The inverters shall be manufactured according to relevant international standards and in compliance with the local requirements of the country/region in which the inverters will be installed, as well as grid operator requirements;
- The inverters provided shall have euro efficiency $\geq 97\%$ and peak efficiency $\geq 98\%$;
- The inverters provided shall have high reliability (expected availability $\geq 99\%$);
- The inverters shall be designed to local climatic and environmental conditions;
- The inverters shall be capable of operating with Third Party monitoring systems;
- The inverters shall be able to accept remote signals for the power quality regulation of such as active / reactive power and power factor;
- The inverters shall be able to operate in a power factor range from 0.8 leading to 0.8 lagging and shall meet specific reactive power management requirements specified in the CUOSA;
- Inverters will be designed to achieve THD within limits specified in IEEE 519-2014 or IEC 61000-3;
- Inverters shall have suitable earthing and bonding;
- The inverters shall be equipped with:
 - DC fuses or circuit breakers. The protections installed in the inverter (or in the DC cable connection panel) shall protect the DC cable connected to the inverter DC input;
 - A DC general on-load disconnect for each inverter to isolate the inverter from the PV generator;
 - Surge protection devices to protect inverters from AC and DC overvoltage;

- An AC side automatic circuit breaker to protect and isolate the inverter;
- Suitable ventilation in order that there is no inverter power de-rating in high ambient temperatures conditions. The inverter shall also include protection in the event that internal temperatures fall outside of specification;
- Integrated interface to allow for modifying operational parameters and displaying settings, main production variables, warnings, alarms and faults;
- Monitoring of signals including, but not limited to, insulation integrity, grid parameters and inverter temperature;
- Each inverter shall be able to communicate through Ethernet or RS485 or RS232 ports or Power Line Communication or Fibre;
- Inverters shall be capable of operating in a temperature range of -25°C to +55°C and a relative humidity range of 5% to 95% and in the Site Conditions; and,
- String inverters shall be mounted in such a way as to not interfere with the operational range of the tracker.

9.5. LV/MV Transformers

LV/MV transformers shall transform electricity from the inverter output voltage to 22/33 kV AC.

- Step up power transformers shall be oil filled transformers from a proven manufacturer;
- The transformers shall have a design life of at least 30 years;
- The mouldings of the windings should contain no halogen compounds (chlorine, bromine, etc.) or other compounds capable of producing corrosive or toxic pollutants;
- The oil filled transformers shall be chosen to include the following;
- The insulating oil shall be free of polychlorinated biphenyl;
- An environmentally preferred dielectric fluid shall be used which also maximises performance;
- A low flammability dielectric fluid shall be used;
- A detection, measurement and control relay protection device is to be included within the transformers specification which will raise an alarm where the following conditions occur;
- Winding temperatures;
- Oil temperature;
- Small or major oil leakage and oil level monitoring;
- Buchholz relay protection shall be included with accessories providing two stage protection – (i) alarm and (ii) trip;
- Where necessary (concept to be agreed with the Employer), functionality will be provided for alarms to trip the MV protective switchgear to isolate the transformer. Terminal blocks for external connection of the alarm contacts shall be mounted in the low voltage compartment of the transformer;
- The transformer should include but not be limited to the following accessories;
- Pressure relief valve;
- Oil filling point, oil draining valve and oil sampling point;
- Oil level and temperature indicators (clearly visible);
- Appropriate lifting lugs;
- Suitable earthing and bonding including earthing terminals;

- If the site is within close proximity of a coastline or another high saline environment the transformers will be equipped with special protection against salty air and dust to prevent reduced life time. If a breather is included, then it should have silica gel to prevent moisture ingress into the transformer tank;
- The LV/MV transformers shall have a vector group according to the Employer's design specification and/or in line with local regulations or requirements of the CUOSA;
- The primary (MV) winding of the transformer shall have $\pm 2 \times 2.5\%$ rated off-load tap changers;
- Transformers shall have provision for installation by lifting, jacking or rolling into position;
- Transformer shall be compatible with the inverters in terms of transformer low voltage level, THD and k-factor;
- The transformer's core and neutral connections should be separable through a link and should be individually accessible from outside;
- Transformers shall be capable of operating in a temperature range of -25°C to $+55^{\circ}\text{C}$ and a relative humidity range of 5% to 95% and in the Site Conditions; and
- If the transformer is to be connected to inverter by means of coupled LV busbars, then the transformer LV bushings shall support such busbar connections to provide a rigid and secure connection.

9.6. Inverter Enclosures (if applicable)

If a central inverter solution is chosen, enclosures shall comply with the following minimum specifications:

- Inverter enclosures shall be designed to house relevant equipment, which may include one or more inverters, a transformer and switchgear;
- Central inverter enclosures shall be in the form of pre-fabricated lockable substations or in an outdoor installation protected with weather-proof material to at least IP54 protection degree. Enclosures shall be designed to ensure equipment within the enclosures remains functional within weather conditions at the site specified in the Contract;
- Containers shall be of suitable size and weight to allow ease of delivery, installation and maintenance;
- Where more than one inverter is housed in a single inverter enclosure, the inverters will be connected and protected on the AC side in a low voltage switchboard provided by the Contractor;
- Satisfactory air flows should be maintained inside inverter containers in order that there is no inverter power de-rating in high ambient temperatures. Inverter enclosures must if necessary be fitted with heaters in order that the operational temperature ranges of the inverters are not compromised under any circumstances and humidity heaters. If the site is within close proximity of a coastline or another high saline environment the enclosure will be equipped with special protection against salty air and dust to prevent reduced life time of the enclosure or its internal components. The enclosure ventilation system should be fitted with suitable filters prevent ingress of dust/ contamination;
- Cable wells are to be fully accessible for maintenance. All incoming cable ducts to the enclosure shall be filled and glands to be fitted on cable entrances to prevent any water ingress;

- Enclosures will be supplied with door locks of an appropriate specification to ensure access can only be achieved by permitted individuals. All door locks must have adequate weather proofing to prevent corrosion and maintain the correct operation of the lock;
- Suitable auxiliary supplies system for all the equipment in the cabin including but not limited to inverters, protections, ventilation, communication, lightning and power sockets;
- Suitable earthing and bonding shall be provided;
- Enclosures shall have provision for installation by lifting, jacking or rolling into position;
- Inverter enclosures shall be capable of maintaining an appropriate environmental for internal equipment in a temperature range of -25°C to +55°C and a relative humidity range of 5% to 95% and the Site Conditions;
- The stations are to be sited in positions that ensure no shadows fall on the array that impact performance;
- Cable wells are to be fully accessible for maintenance. All incoming cable ducts to the Power Conversion Block shall be filled and glands to be fitted on cable entrances to prevent any water ingress;
- Enclosures shall be suitably designed and raised above ground level to prevent flooding; and
- Measures to prevent vermin entry shall be put in place.

9.7. Trackers

The following aspects shall be taken into account when selecting the tracker and the mounting structure configuration:

- Mutual shading;
- Minimum distance from the ground;
- Back-tracking functionalities or equivalently proven control logics;
- Installation requirements;
- Maintenance requirements;
- Cabling requirements;
- Power requirements;
- Control requirements; and
- Site Conditions.

Where bifacial modules are to be employed, tracker components shall be designed so as to minimise shading of the rear side of the PV modules. This includes aspects such as:

- Purlin design;
- Module spacing – avoid placing modules over torque tube flanges;
- Module clamping; and
- Torque tube – module positioning.

The following minimum requirements apply to the trackers:

- The trackers shall be of horizontal dual- or single-axis tracking type;
- The trackers shall have a proven track record in terms of performance and operation;

- Structural components for the trackers shall be comprised of aluminium or galvanised (or other corrosion protection coating as approved by the Employer) steel. Galvanisation coating thickness shall be suitable for the anticipated site-specific corrosion rates;
- Pile saturation and pull-out test (including but not limited to lateral, uplift, and downward force) shall be completed in line with design requirements;
- The trackers shall be supplied with aluminium / steel clamps to the torque bar for the purpose of clamping photovoltaic modules. The Contractor shall ensure that the clamping system is compliant with all requirements of the module manufacturer, including technical requirements the PV module warranty;
- The module clamping system shall not employ rivets or other equivalently permanent fixations;
- The torque bar shall rotate on low-friction high-durability bearings which allow escape of sand to avoid damage. Bearings can be made of plastic materials (such as Nylon 6) and shall be maintenance-free;
- The rotation of the torque bar shall be driven by brushless DC or AC electric motors. IP protection and operating temperature range of the motor and electronics shall ensure the correct operation of the components and shall be in line with good industry practice;
- The trackers shall be supplied with appropriate electrical protection for motors and electronics;
- The torque bar can be driven by wires or levers, or another technique subject to Employer approval;
- The system should be designed to control the frequency and magnitude of the oscillations in case of high wind speed conditions, including minimising the effect of potential harmonics;
- The control system shall be implemented in a PLC or in a PCB, and housed in an enclosure which shall have the required degree of protection and at least IP65 to prevent entrance of dust and water in the electronics. The tracking technique shall be based on an astronomical algorithm. Contractor may propose other techniques if an effective advantage is duly demonstrated;
- Clamping system should allow the module frames to be bonded to the tracker structure, which shall be appropriately earthed;
- Provision for double bolted earthing connections between the torque tube and posts shall be incorporated into the design;
- Trackers shall be capable of operating in a temperature range of -25°C to +55°C and a relative humidity range of 5% to 95% and in the Site Conditions;
- The tracking range shall be at least $\pm 50^\circ$ with a resolution of 1.0° , accuracy of $\pm 2.0^\circ$, and with backtracking capability;
- Trackers shall be provided with an appropriate ground clearance to avoid damage to modules and allow effective maintenance works;
- Trackers shall include an active rather than passive stowing mechanism, all components, wiring, sensors and control algorithms required to provide a complete active safety stowing mechanism shall be supplied. This will include, but not be limited to, the supply of anemometers and stowing tracker controllers. The active safety stowing system shall bring the trackers to stow position in case the wind speed is above a certain threshold to ensure the integrity of the tracking system. The choice of threshold will be approved by the Employer;

- Trackers shall include, and be capable of implementing, a hail stow strategy, the details of which will be approved by the Employer (the wind stow strategy shall take priority over the hail stow strategy);
- The trackers shall allow recording and transmitting parameters, events and alarms. It shall support the state-of-the-art industrial communication protocols and allow the integration into the SCADA system of the PV plant. The choice of the monitored and controlled parameters, events and alarms will be agreed with the Employer; and,
- Twist along a row of modules should not exceed 0.1° per meter under normal tracker operating conditions.
- Installation restrictions in terms of ground levelling and maximum slope shall allow a certain degree of flexibility and tolerances shall be suitable for the Site.
- Power consumption details and calculations, for externally powered trackers, are to be provided for review;
- Where non-centralised trackers (trackers without drive beams linking rows) are employed, no permanent obstructions (e.g. cable trays) may be placed between mounting structure rows;
- The trackers shall be capable of mounting lightning finials/rods for PV module protection;
- Preferably; trackers will be self-powered (with their own solar/battery power supply, i.e. not drawing power from the PV array); and
- Communication cables are to be fibre optic rather than metallic, or alternatively, wireless communication for the trackers may be employed.

9.8. PV Combiner Box (if applicable)

Strings of PV modules shall be combined in parallel in a combiner box of a required IP 65 (or above) rating. Combiner boxes will be supplied for a maximum voltage consistent with that of chosen modules. The combiner boxes will have the following characteristics:

- Suitable for outdoor installation;
- UV resistant;
- Be halogen free;
- Lockable with standard padlocks;
- Have suitable earthing and bonding;
- Feature external isolation, and be capable of fully isolating internal components;
- Feature surge protection devices for lightning protection on auxiliary power, PV generation, and communication circuits;
- Include string fuses adequately spaced for heat dissipation in accordance with the site conditions and thermal input/output of the combiner box;
- Ventilation lugs shall be provided to prevent condensation forming inside panels;
- Capable of operating in a temperature range of -25°C to +55°C and a relative humidity range of 5% to 95% and the Site Conditions; and
- Be capable of interfacing with a monitoring system based on an in/out DIN rail terminal block, using fibre optic media.

Combiner boxes shall have the capability to monitor string current and voltage and will be connected to the centralised monitoring system with the following interfaces:

- Fibre optic (for communication cables longer than 5m that are outside of buildings or structures) or power line communication (if required);
- Monitored voltage arrestors DC;
- String current monitoring; and
- Busbar voltage monitoring.

9.8.1. DC Fuses

Integrated DC circuit breakers or approved PV DC string fuses are to be installed in all non-earthed poles inside the combiner box.

The fuses shall be sized such that the nominal fuse rating is less than or equal to the cable current carrying capacity derated for the specific installation conditions of the cable it is protecting.

The selection, design, and installation must fully comply with all relevant applicable regulations and particularly according to IEC60269-6. Additionally:

- The string fuse shall be rated for the system voltage (1,500 V_{DC});
- The string fuse and main DC fuse must be selected with an operating current (I_n) with respect to the rated current capacity of the circuit (the module short circuit current at STC); and,
- The I_n rating of the DC protection device shall also take into account both the fuse and the PV module manufacturer's recommendations.

9.8.2. DC Isolation

A suitable load-break switch disconnecter or equivalent isolation device must be installed at the inverters DC input or internally to the string inverter. The switch shall be readily and easily accessible.

Suitable load-break switch disconnectors must be installed at each combiner box to enable isolation at the sub-array level. The switch or motorized emergency stop-button shall be installed in such a way to be operated from the outside of the combiner box.

The switch disconnecter installed on the DC side shall have the following features:

- The switch must isolate all live conductors (typically double pole to isolate PV array positive and negative conductors);
- The switch must be rated for DC operation at the system maximums for voltage and current as calculated; and
- Notwithstanding any other provisions of the ER's or standards referenced therein, the switch may be either of type DC-PV21B or DC-PV2.

The switch must be labelled as "PV array DC isolator", with the ON and OFF positions clearly marked and be capable of being "locked out". Switch enclosures shall also be labelled with "Danger - contains live parts".

9.9. Substation and O&M Building

The Contractor is responsible for the design, procurement, and construction of the on-site substation and for the provision of all furniture and equipment required. The Contractor shall provide the Employer with proposed furniture specifications and layout plans prior to installation for Employer's approval.

The Contractor must provide all the necessary heating, ventilation and air conditioning, electrical power, lighting, communications, internet and security, fire detection, emergency exits and hydrants, drainage, trenching, structural, adequate potable cold and hot water, and sewerage services for the substation building, as required by that building's function. These must be designed to be appropriate for the specific Site Conditions including consideration of climate and geotechnical conditions. For the avoidance of doubt, the Contractor's scope of work includes all correspondence with authorities and commercial entities associated with provision of utilities, and sourcing permits and appropriate commercial agreements to ensure all utilities are available to the Facility for its design life.

The Facility substation building shall contain the following rooms:

- Facility MV switchgear and room(s);
- Control/SCADA/meter room; and,
- One toilet (if not co-located with the O&M building)

The O&M building shall have the following general areas:

- Two offices (suitable for 3 staff members each);
- One boardroom with seating for 20 people;
- One kitchenette suitable for the preparation of drinks and light snacks;
- Four toilets and a separate single shower;
- Area for staff members to sit down while eating;
- One Storeroom; and
- One SCADA/server room;

Should the O&M building not be within sight of the Site entrance, then a separate security building shall be provided. Such security building (or room within the O&M building, as the case may be) shall house up to 2 security personnel, a CCTV monitoring station, toilets (if not collocated with the O&M building), and the necessary utility supplies (water, electricity, internet, etc.).

The staffed areas and the boardroom room shall be provided with air-conditioning.

Switchgear room will be appropriately sized consistent with all applicable Laws and Standards. Rooms will be provided with appropriate climate control to ensure switchgear and transformers remain within environmental specifications.

The control/SCADA room shall be appropriately sized for all SCADA equipment. Adequate HVAC shall be provided to this room to ensure a temperature range of 10 – 20 °C within the room at all times and/or to meet requirements of the SCADA system design.

The meter room shall be appropriately sized for the meters specified in the CUOSA and PPAs.

A suitable storeroom shall be provided. The storeroom shall be sized to accommodate the full set of Spare Parts. The stores shall also retain spares to carry out recommended routine and scheduled servicing of the Facility.

The Contractor shall implement access control arrangements for all relevant enclosures, including the switchgear and transformer room, control/SCADA room, meter room, and storeroom so enclosures can only be accessed by the authorised and suitably qualified on-site and O&M personnel.

The Contractor shall calculate the maximum energy demand of the Facility taking into account all active and reactive loads so as to inform the Employer's Notified Maximum Demand ('NMD') contracted from Eskom. Should this be breached by the Facility, the Contractor will be liable for any penalties imposed by Eskom on the Employer. The Contractor shall ensure that during ramp-up and ramp-down of production every morning and evening, that the Power Plant Controller is able to limit reactive power generation so as not to effect the maximum demand of the Facility. Demand of the facility is measured by Eskom in kVA when active power is flowing into the Facility from the grid.

9.10. Energy Meters

Energy meters shall be supplied consistent with requirements of the CUOSA and PPAs. At a minimum the following requirements shall apply:

- All electrical measurements shall have a range extending up to at least 120% of the maximum rating of the equipment;
- To have a Class 0.2 (as per IEC 60044-1) accuracy rating, or in line with local regulatory requirements;
- Check meters are to be installed, irrespective of local connection requirements; and,
- Quality of Supply meters are to be installed at the Point of Connection.

Where applicable, a metering solution to the same requirements shall be installed where a separate LV supply connection point is implemented.

9.11. Electrical Protection

Protection systems shall disconnect the Facility (with correct discrimination) to minimise damage from faults. Main and backup or dual protection schemes, as selected by the Contractor, shall be installed using modern protection relays.

9.11.1. AC Protection and Circuits

The safety switches / circuit breakers to protect the electrical components against short circuits and overload must comply with the relevant parts of IEC 60898, IEC 60715 and IEC 60947 and local Standards.

The electrical installation must comply with IEC 60364 and especially part 7-712 "Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems".

9.11.2. HV and MV Switchgear

The Contractor shall design and specify Facility switchgear to comply with all relevant regulations and design requirements as set out by the GNSP in the CUOSA and the Authorisations. The selected switchgear must comply with IEC 62271.

All MV and HV switchgear will be selected with the following parameters in mind to ensure optimisation.

- The primary current of the transformer;
- The insulating medium of the transformer;
- The position of the Substation with respect to the load centre;
- The kVA rating of the transformer;
- The distance from switchgear to the transformer; and,
- The use of protection relays suitable for the purpose of the switchgear.

A sequential energisation mechanism shall be included to limit the total inrush current on energisation, as required to maintain suitable voltage levels at the connection point.

Switchgear should consist of:

- One motorised circuit breaker for protection of high voltage transformers/grid;
- One on-load switch disconnecter per incoming feeder;
- Switchgear shall include the following characteristics;
- Gas or air insulated switchgear of circuit breaker type or load-break switch suitable for purpose;
- Contain all necessary relays for control of the switchgear must be state-of-the-art and comply with relevant IEC/IEEE standards;
- Include metering and protection CTs and VTs¹;
- Include interface protection at the point of connection with the external grid and shall also include the current protection relays (50-51, 50-51N, 67/67N, 27, 59, 81, 86);
- Incorporate all necessary measuring and metering devices;
- Include local current and voltage metering indicators for all switchgear units;
- Earth switching;
- Suitable earthing and bonding;
- Include provision for providing status and live HV indication to operators;
- Provision shall be provided for integrating the remote control and status indication from the circuit breaker, switches and relays to the control room through SCADA;
- Switchgear should be controlled by interlocking keys where required to ensure strict compliance with correct operating/isolation sequences. The interlocking mechanism shall ensure the personnel and equipment safety and include following interlocks as minimum;
 - between switch disconnecter and earth switch;
 - between earth switch and circuit breaker;
 - cable compartment covers (when switchgear is live); and
 - covers containing any live parts;

¹ VTs only applicable to substation switchgear

- Switchgear shall provide easy access to the cable compartment for maintenance; and,
- Switchgear shall be capable of operating in a temperature range of -25°C to +55°C and a relative humidity range of 5% to 95% and in the Site Conditions.

9.11.3. Low Voltage AC Protection and Auxiliary Services

The Facility design will include suitable provision of low voltage AC power to serve the necessary auxiliary loads, such as: power supplies for monitoring and weather systems, UPS system, if applicable, inverter ventilation fans, power outlets and lighting, etc. AC power may be provided from auxiliary transformers, direct low voltage connection to the grid, via string inverters, or via another methodology accepted by the Employer.

9.12. Lightning Protection and Earthing System

9.12.1. Lightning System and Overvoltage Protection

A lightning and overvoltage protection system shall be designed according to IEC 62305, all parts and country-specific regulations. The Facility shall be equipped with a Lightning Protection System ('LPS') whose Lightning Protection Level ('LPL') as defined in IEC 62305, should be defined by a Lightning Risk Assessment ('LRA'); however, regardless of the results of the LRA, the following minimum requirements of the LPS are to be respected:

- Structural and electrical protection covering all components of the Facility (including the PV module arrays);
- LPL level 3 or better; and,
- Design of the LPS to achieve a Residual Harm (calculated in accordance with IEC 62305) of R1,500,000 (2024 terms) or lower.

The Contractor shall appoint an appropriately qualified in-house or 3rd party to conduct the LRA. This LRA and the credentials of the party who conducted the LRA shall be submitted to the Employer and LTA for review not later than 3 months after receiving the Notice of Commencement.

The Residual Harm, achieved by the Contractor's design, shall be calculated by an appropriately qualified independent consultant engaged by the Contractor.

The LRA must be undertaken to define the protection against physical damage to structures, life hazard and protection of electrical and electronic systems. The LRA should consider protection requirements from site mobilisation and the protection scheme to be implemented for the temporary construction compound.

The main components and systems belonging to the Facility's lightning protection system are listed below:

- External lightning system (structural lightning protection); and,
- Internal lightning protection (electrical and electronic system protection).

The external (structural) lightning system shall consist of an air termination network, down conductors, and bonding connections to the earthing system.

The internal lightning protection of the installation shall mainly consist of surge protection devices at the origin of the power and communication lines and near to the electrical components to be protected, and will be rated to ensure their protection against overvoltage as per the lightning risk assessment or the specific overvoltage protection study.

9.12.2. Earthing System

The Contractor shall provide the complete earthing system to provide a safe Facility. During pre-construction, an earthing study will be undertaken for the estimation of the earth potential rise expected for the Site. The earthing study shall include Soil Resistivity Testing and various locations on the site in accordance with IEC BS EN 50522 (all 14 recommended Wenner spacings from 1m to 100m). The earthing arrangement will be designed and installed based on the results and recommendations made in the earthing study and according to the Applicable Standards and Regulations for the Facility. Compatibility with the expectations of the study should be verified after the implementation of the earthing system.

The cross-sectional area of the earthing conductors should be chosen to carry, without danger, the greatest earth fault currents and leakage currents likely to occur while having regard to thermal and electromechanical stresses.

The earthing system and its connections and components must be designed to have adequate mechanical strength, protection and stability against corrosion including oxidation, formation of an electrolytic couple, electrolysis, etc.

The earthing design must respect the permissible touch voltage and permissible step voltage, transferred potentials and electromagnetic compatibility requirements according to the Applicable Standards and Regulations for the Facility. Furthermore, the earthing system shall be designed, constructed and erected to safely withstand the mechanical and thermal effects resulting from short-circuit currents.

The earthing system shall be consistent with any requirements of the CUOSA, and will consider and be compatible with any earthing systems to be installed by the GNSP.

9.12.3. Equipotential Connection

All non-current-carrying metallic components, cases and structures shall be connected to each other and to the earthing system.

Module frames shall be installed according to the manufacturer's specifications. Whenever these require earthing of the frame, this shall be executed in compliance with the manufacturer's specifications. Alternative solutions may be approved by the Employer and by the manufacturer. Bonding straps shall be bolted. Self-tapping screws are not acceptable.

Adequate grounding must be maintained throughout all metal work across the Facility through adequate bonding connections to the main earthing grid as per earthing design. All electrical

systems and exposed metal work must be considered within the design of the earthing system and connected where required.

9.13. Cable Selection, Design, and Connections

All cables with sections or lengths exposed to Site Conditions shall be appropriately selected to be resistant the Site Conditions.

9.13.1. Cable Sizing

The cables used for wiring each section must be selected based on relevant Standards and to ensure that they can withstand the extremes of the environmental, voltage and current conditions, under which they may be expected to operate.

The cable sizing of the generation DC, HV AC, MV AC, LV AC, and auxiliary supplies LV AC, shall comply with the following criteria:

- Ampacity criteria: The ampacity of a cable, or current carrying capacity for continuous service, is the maximum current that can flow through a cable, considering the particular method of the installation, load patterns, and environmental conditions, without damaging the cable's insulation and other components. The cable should be sized to withstand their ampacity for the entire lifetime of the project;
- Short circuit criteria: In short circuit conditions the current flowing through the cable increases causing a temperature rise within the cable. Cables should be sized in such a way as to be able to withstand the largest possible short circuit current; and
- Voltage drop criteria: the voltage drop in any circuit must respect the component specification, where component nominal voltage range specifications are not available, then the maximum voltage drop should be respected according to the applicable Standards.

The maximum current carrying capacity must be established according to best practice and the manufacturer information, always taking into account the type of cable and the installation methods. Thermal dimensioning of DC cables shall be based on heat load values evaluated in accordance with the manufacturer's recommendations and relevant sections of IEC60228 and IEC60364 or equivalent.

Notwithstanding any other requirement, sizing of DC and AC cables based on cyclic loading principles, as described in IEC 60853, is acceptable.

All above ground cables require adequate support through the use of cable tray / basket or shall be installed so as to ensure:

- Cable weight is adequately supported;
- Cables conform to minimum bend radii;
- Cables and connectors are not stressed or under undue tension;
- Cables are protected from sharp edges;
- Cables are secured so as to avoid swinging of cables due to wind; and,
- Cables and connectors are prevented from contacting the module backsheets or any other object potentially causing damage to the cable or connector or the object itself.

The cable connectors will fulfil at least the requirements of IP67.

Cabling and stringing arrangements shall be in accordance with the inverter installation manual. Cabling routes should be optimised for the shortest possible distance in order to prevent additional cable losses.

The installation method chosen by the Contractor must cause no damage to cable sheaths during handling or installation and pulling forces on cables must be minimised. Minimum bending radii of cables shall be followed as per the manufacturer's recommendations and good practice.

Underground cables must be protected from damage by termites, rats, mice, rabbits and other animals.

9.13.2. DC Cables

Cables used in the DC distribution network shall be especially designed for PV systems and:

- Be resistant to ultraviolet radiation and ozone;
- Have an enhanced resistance to heat and fire and with low smoke emissions;
- Operate in an extensive temperature range compatible with site conditions;
- Be rated to the appropriate DC voltage 1,500V; and
- Be double insulated.

9.13.3. Medium Voltage Cables

The cable specification must be fit for purpose and in line with the requirements of the GNSP for the Facility and relevant Standards, codes and regulations.

In most cases MV cables shall include 3 single cores cables and an earthing conductor in twisted configuration. Each single core cable shall include:

- An aluminium or copper conductor of suitable size;
- Semi-conductive conductor sheathing;
- XLPE insulation;
- Metallic screen made of aluminium or copper strands; and
- Protection against ingress of water and an outer jacket.

The cables shall have the following application characteristics:

- Cable for fixed installations;
- Adequate for the transmission and distribution of energy in high-voltage networks. Suitable for interior, exterior, and underground installations; and
- Low halogen content cable with low emission of smoke and non-propagator of fire.

9.13.4. Communication Cables

Communication cables outside of buildings or structures that are longer than 5 meters must be fibre-optic, rather than metallic conductors. Where this is impossible, e.g. for inclinometers, the cables must be suitably specified and designed (i.e. shielded, earthed conduits, surge protected,

etc.) to prevent any harm to other components of the Facility from voltage surges or induced currents.

9.13.5. In the case of power line communication, the solution must comply with requirements of the inverter, SCADA and power line communication manufacturer.
Auxiliary Power Cables

For the avoidance of doubt, all auxiliary power cables shall be protected by surge protection devices as per EN 61643.11 and .12 or equivalent local standard.

9.13.6. Cable Runs and Trenches

The technical requirements for cable runways/trenches include the specifications set out here. Local standards shall apply if more conservative or compulsory.

Buried cables within 600 mm below surface shall either be armoured or otherwise protected from mechanical damage. The Contractor shall assess the Site for potential harm from fauna and institute adequate protection measures for all cables contained within the ground.

Where cables are run within ducts or conduit, the mechanical protection must be appropriately sized to ensure thermal capacities are respected and to reduce resistive losses from the cables. The cables shall be protected from metal edges and openings. Underground cables must be protected from damage by termites, rats, mice, rabbits, and other animals.

The bottom of each trench shall be as level as possible and any change in gradient or level shall be made as gradually as possible. Trenches shall be free of stones and other sharp objects and the edges of the trench shall be cleared of any stones, tools or objects which may fall into the trench and damage the cable. Cables shall be covered by an appropriate material in line with their specifications and at a burial depth to be agreed with the Employer.

9.13.7. Cable Jointing and Termination

Cable joints shall not be permitted without written approval of the Employer, any approved cable jointing necessary must be made within designated buried jointing bays or above ground jointing enclosures and clearly identified.

9.14. Backup Power Systems

The Contractor shall design, supply, and install appropriate backup power systems and procedures to allow the Facility to maintain visibility and be able to be promptly restored to operation following an outage.

The backup power systems will consist of Uninterruptible Power Supplies ('UPS's') and LV auxiliary power based on battery, battery charger and solar module and/or diesel generators which shall have sufficient capacity to supply the required load for a period of at least 8 hours, unless otherwise required in relevant Standards or GNSP requirements. UPS protection shall be provided for:

- HV switchgear;

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- Security system;
- Weather station(s) and SCADA system;
- At least one tracking PV module mounting system (on which the reference pyranometer is mounted), unless the trackers are self-powered (so as to allow for in-plane irradiance measurements during grid outages); and
- Inverters if required by the GNSP/local regulation.

9.15. SCADA System

9.15.1. Key Functionalities and Requirements

The SCADA system shall comply with, but not be limited to, the following functional specifications:

- Provide real-time monitoring of the key parameters of the Facility;
- Ensure data acquisition and recording for the lifetime of the Facility (historical information/archiving system) including, but not limited to, all data, events and alarms required for maintenance and operation works and PV plant performance analyses;
- Manual and automatic control features;
- Alarms generation, processing, notification, historical archiving and management system;
- Automatic and manual flexible reporting features (daily, weekly, monthly, yearly);
- User friendly and flexibly query of historical data, alarms and events;
- Generate graphs for data trending analysis;
- Export data, alarms and events in standard editable formats e.g. *.csv, *.xlsx;
- Provide concurrent local and remote access to authorised users;
- Web based and friendly graphical user interface, including all mentioned key functionalities and features;
- Allow the integration and operation of Employer's and third parties SCADA systems, including remote retrieval of data and certain control features (where applicable);
- Redundancy for key components, such as central server, database, power plant controller(s), internal communications backbone (fibre optic cable ring), internet access and interface to third parties (where applicable) such as Utility's SCADA system and GNSP dispatching centres, to prevent/minimise loss of data and communication issues;
- Use of open industry automation and communication protocols (e.g. Modbus, DNP3, IEC 60870-5, IEC 61850, OPC UA, IRIG timecode, NTP, PTP, etc.);
- Use of cybersecurity mechanisms (e.g. firewalling, VPN connections) to ensure secure access and protect the system against external cyber threats;
- Support different access level depending on user roles (e.g. viewer, operator, engineer) to protect the integrity of the system and prevent unwanted, unwarranted and/or unsafe Facility configuration changes;
- Allow customisation and automation of reporting;
- Analyse SCADA system health/status, including hardware (e.g. servers, power plant controllers, etc.), software (e.g. database, Human Machine Interface, etc.), internal and external communications and interfaces to the GNSP and third parties; and

- A local workstation, including desktop computer, keyboard and mouse, printer with a suitable number and sized screens (to be validated by the Employer) shall be provided for local access to the SCADA system by the operators of the PV plant.

The SCADA system shall:

- Comply with the requirements for Class A monitoring systems defined in IEC 61724-1;
- Comply with the CUOSA, PPAs and Grid Codes;
- Provide controlling capabilities of the grid parameters at the Point of Connection to meet any applicable requirements such as active power curtailment, ramp rate control, dynamic grid support such as voltage regulation, reactive power (Q) control, power factor control, Q at night, etc;
- Be designed and built for the operating lifetime of the Facility;
- The SCADA system and all its applications shall be provided with a permanent and comprehensive license, and therefore, there shall be no recurring fee over the lifetime of the Facility. An agreed number of user licenses shall be provided to the Employer;
- Critical SCADA components shall be fed with secured power by means of an UPS properly sized and supplied by an alternative power supply if required to ensure a minimum operation time of 8 hours in the event of an outage in order to prevent loss of data and ensure graceful shutdown of the SCADA equipment. Critical components shall include, but not be limited to, central electronics and software, operator local workstation, all hardware related to internet access and interface to third parties and other critical field equipment such as remote terminal units, IEDs, power plant controllers and weather stations;
- The key components of the SCADA system (e.g. servers, power plant controllers, remote terminal units) and monitored equipment (e.g. IEDs, energy meter, weather stations) shall be synchronised by means of a GPS based time server and industry standard network time protocol(s);
- The Contractor is responsible of providing a complete, functional and comprehensive SCADA system, including but not limited to, the design, supply (all required hardware, software and wiring), installation, integration, development and commissioning of the system; and,
- All SCADA hardware and cabling shall be designed and rated to operate within the environment weather conditions applicable to the Facility. SCADA equipment shall be industrial rated with enclosures, cabinets and racks properly designed to ensure that the hardware will be operating within the temperature and humidity ranges according to the manufacturer's recommendations.

A suitable user-focused training session shall be provided to Employer's and Operator's personnel. It shall cover all required aspects of the SCADA system from the user point of view.

9.15.2. Data, Events, and Alarms

Data, events and alarms will be agreed with the Employer. The following equipment shall be considered in the SCADA system design:

- Trackers (where applicable);
- String boxes;

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- Inverters;
- Grid transformers;
- LV/MV transformers;
- MV/HV transformers and load tap changer - where applicable
- Capacitor banks, static synchronous compensator and/or static var compensator – where applicable;
- Auxiliary transformers;
- LV/MV switchgear;
- MV/HV switchgear (where applicable);
- Revenue meters;
- Power quality meters;
- Power plant controllers;
- IEDs;
- Weather stations;
- UPS system;
- Interface with GNSP in line with the applicable regulations, Codes, Laws, CUOSA and Grid Codes; and,
- Miscellaneous dependent on project such as ventilation system and temperature of critical technical rooms, substations or buildings, diesel generators, etc.

The SCADA system shall monitor the health (status) of all equipment, and

generate and record alarms in the event of failures to ensure prompt remediation actions and prevent loss of data.

SCADA alarm management system shall be able to categorise alarms by severity (low, medium, high), provide real time status of alarms (e.g. timestamp active, clear, acknowledged, unacknowledged) and supporting details of the issue. SCADA signals acquisition shall comply with the sampling and recording intervals defined in IEC 61724-1 for Class A monitoring systems, and shall be able to be settable (if needed) via software to meet the Facility's needs (e.g. 1 minute, 5 minutes, 15 minutes, 30 minutes, 60 minutes, etc.). Critical alarms shall be notified via email/SMS to ensure prompt intervention of the operators.

A complete SCADA signal list including monitored data, events, alarms and calculated data shall be provided for Employer approval prior to installation of the SCADA system.

The SCADA system shall allow the user to retrieve any historical recorded data, locally and remotely, in standard editable data formats (.xlsx, .csv, .txt or equivalent).

9.15.3. Data Storage

All historical data shall be available during the operational lifetime of the Facility. The Employer shall have unlimited access to the historical data.

All historical data shall be mirrored and stored on a secured offsite server (cloud system), to be agreed with the Employer, with a minimum storage capacity of 25 years and continuous backups

to guarantee availability of all data throughout the entire lifetime of the Facility. The Employer shall have unlimited access to the data backups.

The location of the cloud server will meet the following minimum requirements:

- 24/7 security guard(s);
- Automatic fire suppression;
- Environmental Monitoring;
- Video surveillance;
- Alarm system;
- Air-condition;
- Generator; and,
- UPS (2N+1 power redundancy).

9.15.4. Weather Stations

The Contractor shall design, supply, install, commission and integrated into the SCADA system the weather stations of the PV plant. Six (6) weather stations shall be included at different locations within the Facility boundary so as to represent the average conditions across the site.

The quantities and technical specifications of the weather stations and sensors shall be in compliance with the requirements defined in IEC 61724-1 for Class A monitoring systems.

Each weather station (unless specified otherwise below) shall be equipped, as minimum, with the following sensors:

Weather station:

- Global Horizontal Irradiance: 1x digital pyranometers (Class A, IEC61724, ISO9060);
- Global Inclined Irradiance: 1x digital pyranometers (Class A, IEC61724, ISO9060), to measure the incident irradiation on the plane of the modules;
- Albedometer (at two weather stations only): 1x digital thermopile pyranometers (Class A, IEC61724, ISO9060);
- 1 x Ambient temperature sensor (shielded ventilated);
- 1 x Air humidity sensor (shielded ventilated);
- 2 x Module temperature sensors as minimum (final quantity according to IEC 61724-1);
- 1 x Air pressure sensor;
- 1 x Wind speed sensor;
- 1 x Wind direction sensor;
- 1 x Rain level sensor;
- 1 x Soiling ratio measuring station, according to IEC 61724 and including both measurement methods 1 and 2; and,
- Lightning detection/warning system (at the primary weather station and if required by the LRA only).

Suitable solutions should be provided to measure the module temperature for projects with bifacial modules. Supplier calibration certificates shall be provided for each Individual sensor.

Each weather station shall be equipped with an industrial rated data logger with the following minimum specifications:

- Enough data capacity to prevent loss of data in the event of an electrical outage or communication issues;
- Shall be powered with a secured power supply system (LV auxiliary power together with an UPS system based on battery, battery charger and solar module to ensure the continuous operation of the weather station even in the event of a long-term outage);
- Supporting standard industrial protocols (e.g. Modbus TCP, DNP3) for reliable communications and easy integration into the SCADA system; and,
- Installed in an enclosure suitable for outdoor and rated to ensure the protection of the data logger and other electronics and electrical equipment housed in it.

9.16. Security System

The Contractor shall design, install, and commission a security system that shall meet the minimum requirements outlined in this section and put in place a security strategy that is satisfactory to the Employer. The design of the security system and security strategy shall be submitted to the Employer for approval.

The security system shall accommodate for lightning activity and the consequences thereof i.e. be so constructed as to avoid down-time consequent to lightning and lightning strike activity.

9.16.1. Fence and Gate

Before the commencement of the works at Site, the Facility area shall be secured by installing appropriate fencing.

The final fencing design (including gates for access) shall be approved by the Employer, prior to installation.

The fence shall be continuous along the perimeter and no interruptions, temporary or permanent, are allowed. The fence can be opened only at the site entrance.

Galvanised welded steel wire fence of at least 2 metres (above ground height) shall be installed. Thickness of wires shall be at least 3 mm. Barbed wire (3 straight rows or 1 coil/spiral) shall be mounted on top of the fence as an anti-climb guard. The fence shall be electrified on the inside with strands spaced no more than 15cm apart running the full height of the fence panel. The electric fence shall be linked to the Facility security and SCADA systems, thereby alerting security personnel to breaches or attempted breaches. The aperture of the welded steel mesh shall be small enough to prevent complete penetration of a standard test finger (as defined in IEC 60529).

There shall be a gate for pedestrian access with electronic access control measures (e.g. NFC tag activated turnstile) and a separate motorised sliding gate for vehicular access of at least 6m wide. The gate shall be rigid and similar in design to the fence in terms of material, mesh aperture, and electrified strands.

9.16.2. Security During the Construction Phase

During any period when the Site is unmanned, a contracted security company is to monitor the Site on a continuous basis, and conduct periodic patrols. If any suspected theft is noticed this is to be immediately reported to the local police and the Employer. The security company must be able to prove that they have adhered to their walk around every hour and as such a method of evidencing their work is needed.

The security company is to be paid for by the Contractor as part of the scope of works.

9.16.3. Permanent Security Arrangements

The Contractor shall provide an integrated and complete operational security system for the Facility. Intruder detection and surveillance equipment shall be provided for the Site to deter unauthorized access to the Site while permitting ease of access to authorized staff and visitors.

All security measures shall be fully integrated to allow an automatic response to events to aid operator decisions.

The Facility is to be protected from both casual and malicious intrusion.

The security system shall have at minimum the following equipment and systems installed:

- Perimeter security fence and motorised gates;
- Continuous CCTV coverage of the entire perimeter fence and key internal areas including (but not limited to) the O&M building, the workshop and stores, the substation and the main gate;
- CCTV cameras must have low Lux response and be supplemented with infrared illuminators if necessary to maintain visuals throughout the night;
- CCTV cameras shall have a minimum optical resolution of 1920x1080 and minimum infrared resolution of 640x480;
- CCTV cameras shall have a minimum bitrate of 4mbps per camera;
- CCTV cameras shall record at a minimum of 25fps per channel;
- A motion detection system and infra-red (thermal) detection system shall be incorporated;
- All cameras must link to a local central station;
- The central station shall have a minimum recording capacity of 10hrs per day per camera of at least 30 days;
- The central station shall be capable of simultaneous playback and recording on all channels; and
- The surveillance and alarm system shall communicate with the central alarm system, which should also communicate with the system SCADA system.

Forced intrusions and attempts shall be detected by the automatic surveillance and alarm system. The alarm must be able to alert a remote central security location and an appointed representative of the Employer.

All security measures shall be fully integrated to allow an automatic response to events to aid operator decisions. It is the responsibility of the Contractor to ensure that the security systems comply with local regulations.

9.17. Lighting

Sufficient lighting shall be provided to comply with good practice. External security and general external site lighting to building areas including inverter stations and access points shall be provided. For the avoidance of doubt, no perimeter fence lighting is required except for at the access points.

Building perimeter lighting shall be controlled via photo-electric cells and the site lighting shall be switched in circuits by means of externally mounted weatherproof switches.

Energy efficient lighting shall be used as far as reasonably practicable.

In any case, the Contractor shall:

- Minimise the off-site lighting impacts;
- Ensure that all external lighting associated with the Facility;
 - Is installed as low intensity lighting (except where required for safety or emergency purposes);
 - Does not shine above the horizontal; and,
 - Complies with relevant local standards associated with the effects of outdoor lighting.

9.18. Temporary Site Facilities

All work on Site shall be carried out in an orderly and workmanlike manner and shall present a neat appearance in accordance with good industry standards and practice.

The Contractor shall keep the construction site clean and tidy in order to facilitate construction work, to avoid damaging the equipment intended for the Works and to reduce the likelihood of fires occurring and injury to workers.

The Contractor shall supply, erect, and maintain any and all temporary structures such as:

- Site offices for Employer and Employer appointed 3rd parties;
- Site offices for the Contractor's own staff and sub-contractor's staff; and,
- Storage sheds, workshops, tool sheds and employees' amenities sheds, change room, toilets, catering and canteen area and sanitary accommodation, etc.

that are required for the execution of the Works.

Specifically, before the start of construction or compatibly with the presence of labour at Site, the Contractor shall procure to have on Site and in appropriate locations the following facilities:

- Facilities for the Employer;
- Sanitary facilities;
- Potable water facilities;
- Sewage and wastewater facilities;
- Site managers office;
- Security office;
- Storage containers;
- Parking areas; and

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- Loading/Unloading and storage areas;

The sizing of the facilities and amenities provided shall take account of the projected manpower levels.

The Contractor shall provide all surface preparation required and shall supply, install and maintain water supply and drainage systems and a general electrical supply system.

If required, the Contractor shall be responsible for arranging housing at his own expense for construction workers at a suitable location but not on the Site. The housing facilities shall be sufficient to allow the workers good quality rest and sleep.

All facilities shall be regularly and systematically maintained and cleaned to ensure safe, proper and efficient operation at the responsibility and cost of the Contractor.

On completion of the Works, the Contractor shall remove from site all temporary structures and services including sanitary arrangements and shall rehabilitate all parts of the Site impacted by the Contractor's temporary structures and services.

9.18.1. Facilities for the Employer

The Contractor shall provide a temporary Site office solely for the use of the Employer and the Employer's personnel. These offices shall be provided at the same time as the Contractor mobilises to Site.

The Employer's site offices shall be complete with furnishings which shall include 4 desks with chairs, filing cabinets, and air conditioning in each office. Facilities such as photocopier, telephones, high-speed internet service (as per Section 2.4), shelving, toilet facilities, kitchen facilities may be shared with the Contractor's personnel.

All facilities shall be regularly and systematically maintained and cleaned to ensure safe, proper, and efficient operation at the responsibility and cost of the Contractor.

On completion of the Works, the Contractor shall remove from site all temporary structures and services including sanitary arrangements and shall rehabilitate all parts of the Site impacted by the Contractor's temporary structures and services.

10. Form of Progress Reports

The monthly progress report shall be provided in electronic format (.pdf or similar) and shall contain at least the following:

- Facility reference;
- Date;
- Report progress number;
- Brief summary;
- QHSE risks identified, incidents and near misses;
- Environmental events (including near-misses) and issues;
- Major activities executed in the month;
- Major activities planned for the following weeks;
- Project risks and mitigating actions implemented;
- Opportunities for reduced construction time;
- Record of milestones claimed and status of payment (including variations);
- Forecast of upcoming milestone completion dates;
- Resource levels assigned to activities (including person-power allocated);
- Significant existing and anticipated problems / issues / challenges with discussion of potential resolution and/or mitigation;
- Progress of;
- Engineering / design;
- Procurement and material delivery on site;
- Construction;
- After construction services (testing, commissioning, etc.);
- Deliveries to site;
- Connection Works (Owner's and GNSP's side);
- The progress shall be identified with percentages of completion for each of the sub-tasks (i.e. electrical design 50%, civil works design – foundations 80%, etc.). Moreover, progress shall be represented as follows;
- Current progress against Schedule (e.g. Gantt chart);
- S-curve (budget and work completion);
- Critical path activities and reserves;
- Milestone completion;
- Third party approvals or statements required and actual progress;
- Variation order requests (indicating variation, order request status, extra costs, impact on Schedule, mitigants);
- QA/QC facts, including;
- Factory inspections and outcomes;
- Material acceptance at Site;
- Completeness of documentation;
- Post-installation Test Results;
- Status of permits, licenses and authorisations to be obtained, including any changes;

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- Photographic report (photos of main components and photos of works); and
- Environmental, Social and Governance ('ESG') related data (e.g. job creation, local content spend, etc.).

The weekly progress report shall be provided in electronic format (.pdf or similar) and shall contain at least the following:

- Site weather conditions;
- Onsite resources (staffing and equipment);
- QHSE incidents and near misses;
- Environmental incidents or near misses;
- Local community incidents or issues;
- Major activities executed in the week;
- Major activities planned for the following week;
- General progress against Schedule;
- Project risks and mitigating actions implemented;
- Opportunities for reduced construction time;
- Engineering documentation status;
- Resource plan and allocation of personnel;
- Facility planned vs. actual % complete;
- Record of achieved milestones;
- Forecast of upcoming milestone completion dates;
- Significant existing and anticipated problems / issues / challenges with discussion of potential resolution and/or mitigation;
- Problems / issues / challenges specifically affecting progress; and
- Photographic report.

11. Project Specific Contractor Documents

This section contains a non-exhaustive list of Contractor documents which shall be provided during the Contract and execution of the Works.

Up to date copies of all documents, drawings and contract documents including permits and licenses shall be kept at the Contractor's office at the Site, available for use at all times.

The Contractor shall maintain a record of all field deviations from the design drawings and shall submit to the Employer a set of Contractor's Documents in line with the terms prescribed in the Contract.

Contractor's Documents include the following:

- General documents;
- As-built and design documents;
- Design documents;
- Surveys and studies;
- O&M manuals;
- Installation manuals;
- Specifications and data sheets;
- Training material; and
- Other documents.

All Contractor's Documents shall be submitted to the Employer for comment. For the avoidance of doubt this section is not an exhaustive list of documentation, and any other documents mentioned in the Contract or identified by the Contractor as necessary to complete its scope of work must be identified by the Contract and submitted to the Employer for comment.

11.1. General Documents

The following general documents shall be submitted by the Contractor:

- Exhaustive list of codes and standards which shall apply to the Work;
- Traffic management plan;
- Project Execution plan;
- Module handling plan;
- Health and Safety plan;
- Quality plan;
- Environmental plan;
- Emergency response plan;
- Social responsibility plan;
- Interface Management plan; and
- Licence and permitting compliance matrix.

11.2. As-Build and Design Documents

As-built documents shall be in accordance with IEC 62446 and should include, but not be limited to:

- Site plan;
- Array layout;
- Piling depth records and plan;
- Foundation plans;
- Foundation design calculations;
- Structural design calculations;
- Geotechnical report;
- Topographic survey;
- Drainage system design and calculations;
- Site surveys;
- Single line diagrams;
- Electrical plan diagram;
- Electrical cable and conduit lists;
- Electrical conduit, earthing and lightning protection system drawings;
- Earthing designs and layout drawings;
- Final project specifications;
- Design studies and evaluations;
- Detail design drawings of all components installed/works completed;
- Instrument calibration certificates;
- Equipment drawings;
- Schematic diagrams;
- Wiring diagrams;
- System descriptions;
- Calibration certificates;
- SCADA as-built design package;
- Data sheets and specifications of each component;
- Complete component warranty certificates; and
- Bill of materials.

Where applicable, as-built documents should include the design documents listed in Table 6 and be provide in both a native format (DWG, Word, Excel, etc.) and PDF.

Table 5: Design and as-built documentation list

Design and As-Built Documentation List
Electrical
Documentation
Technical Description of the electrical design
Electrical calculation (including all DC, AC, LV, AC, MV, earthing system, and ancillary services calculations) up to the battery limit
Power quality study
Electrical studies including, but not limited to, load flow, short circuit, switching transient, transformer inrush, transient stability and dynamic performance, transient overpower, harmonic analysis, voltage fluctuation, voltage flicker, unbalanced network conditions, and power factor.
Protection studies
Energy production forecast
PVSyst simulation sheets (or alternative simulation software reports)
Electrical loss calculations
Lightning risk assessment and lightning system calculations
Grid integration study as per Grid Code and guidelines
Bill of Quantities
Drawings
General SLD
MV SLD
DC and AC SLD
Interconnection Facility SLD
Design of Interconnection Facility
Detailed string connection plan and string path
Earthing system layout

Earthing system details
Lightning system
Electrical drawing of string combiner / junction box
Electrical drawing of inverter and transformer cabins
Auxiliary services SLD
Layout of cabling (DC)
Layout of cabling (AC)
Layout of cabling (MV)
Layout of cabling (Communication)
Layout of cabling (auxiliary services)
Drawing of UPS and Diesel generator
Typical trenches and crossings
Fibre-optic cabling from PV Facility to Interconnection Point
Layouts of O&M building and substation including overall layout, equipment locations, wiring, ducting
Specifications
PV panel
Inverter
Inverter cabin
MV transformer
LV/MV switchgear
LV cabinets
Auxiliary transformers
Combiner boxes

Cables (DC, AC-LV, MV, communication, earthing, other)
Junction box, combiner box
UPS
Diesel generator
Cabin ventilation
Protection system (pilot protection, over current, short circuit, earth leakage, and any other required protection systems)
Transformer protection system
Metering system
Power Quality analyser
Other
HV Substation
Documentation
Technical description of the design (architectural, electrical, mechanical, electromechanical, etc.)
Structural calculation based on prescribed local conditions (dead, wind, seismic, snow loading) for civil works, foundations, footings, Buildings
List of protection settings
Bill of Quantities
Drawings
Single line diagram (general)
Single line diagram (operating)
Single line diagram (protection and metering)
Single line diagram (communication and SCADA)
Single line diagram (AC and DC systems)

Substation layout (general arrangement)
Substation layout (elevations)
Earthing system layout
Feeders panel equipment layout
Transformer panel equipment layout
Transformer wiring scheme
Transformer protection and control wiring scheme
Bus zone and bus section equipment layout
Bus zone and bus section wiring scheme
Bus zone panel connection diagram
Lightning system (if any)
Auxiliary service wiring scheme
Generator equipment and layout
Generator equipment wiring scheme
SCADA RTU equipment layout
SCADA RTU connection diagrams
Site layout
Site contour plan
Site roads and earthworks cross sections and details
Foundations
Building architectural design
Building electrical services
Building mechanical services
Building cable tray

Building conduit layout
Building earthing
Structures of HV equipment supports
Footings of HV equipment supports
Building earthing
Fire and security scheme and equipment layout
Specifications
HV/MV transformer
Auxiliary transformers
MV switchgears
Surge arrestors
Cable potheads
Supports and bars for HV equipment
Lightning mast
Cable terminations
HV disconnectors
HV circuit breakers
Current transformers
Voltage transformers
Insulators
Reactive power compensators
SCADA system components
Batteries
Battery charger-rectifier

Diesel generator
HVAC system
Meters
Fire alarms
Alarms
Power quality analyser
All other components in the Building
Civil Works
Documentation
Technical description of the civil works, including foundations, earth movements, levelling, geotechnical characteristics
Structural calculation based on prescribed local conditions (dead, wind, seismic, snow loading) for cabins and trackers
Tracker supplier comment on foundation design
Description of the drainage system design
Hydrological calculation report
Bill of quantities (foundations, earth works, roads, drainage system)
Drawings
General PV system layout
Grading details and slopes
Ground movement
Aerial view
Topographic elevation
Design of PV system access
Layout of roads, tracks and storage areas

Cross sections of roads, tracks and storage areas
Drainage system layout and co-ordinates
Drainage system channel details and cross profiles
Drainage system culverts details and cross profiles
Trenches – details
Trenches – layout
Manhole – details
Manhole – layout
Water supply system (fresh and sewage water)
Fresh and sewage water tanks design and supporting infrastructures
Cabin foundation – design
Cabin foundation – details
Tracker foundation design
O&M building and substation civil design
Tracker upper structure design
Toilet facilities
Specifications
Construction material (gravel, geotextile, concrete, crushed stone, sand, iron bars)
Electric ducts
Drain pipes
Manholes
Water tanks (fresh and sewage)
Construction facilities (WC, changing rooms, ...)
Other

SCADA SYSTEM
Documentation
Technical description of the SCADA system (civil infrastructures and network)
Technical description and specification of the Communication system to be installed on Delivery Point according to CUOSA and/or PPAs requirements
Technical description and specification of the communication network between Facility and Point of Connection including equipment, infrastructure, cabling among other required elements;
Documentation regarding configuration, parameters and programming on installed communication system
SCADA development and integration information, including configuration files of the system, SCADA hardware and field devices settings, source codes, software, credentials, licenses and any other applicable related set-up data
User manual and guides
Drawings
SCADA system block diagram (system architecture)
Layout of SCADA system (including location of string monitors, AMR, weather stations, cabinets, server and control rooms)
Full SCADA alarm code list
Communication cabling paths (optic-fibre or similar)
Fibre-optic patch plan
Typical trenches for communication cables
Single-line diagram auxiliary services
Control cabinet – cabling details
Monitoring system – GNSP's side – cabling details
Control cabinet – details (incl. foundations)
Meteorological station layout and installation details

Specifications
AMR interfaces, weather station equipment, meters
Keyboard, computer, monitor, server, UPS
Data communication interfaces (routers, antennas, ...)
Combiner boxes
Junction boxes
String monitoring unit
Cables (optic-fibres, RS485, RS232, ...)
Ethernet switches
Power quality analyser
Meteorological station components (pyranometer, temperature sensors, pressure sensors, humidity sensors, wind vane, anemometers, tower)
Other
SECURITY SYSTEM
Documentation
Technical description of the security system (civil infrastructures and network)
Technical description of the fence design
Manuals of each component
Bill of Quantities
Drawings
Security and surveillance system block diagram
Layout of security system (including location of pylons, cabinets, fence)
Communication cabling paths (optic-fibre or similar)
Typical trenches for communication cables

Single-line diagram auxiliary services
CCTV pylons – details (incl. foundations)
Fence – details (incl. foundations)
Gate – details (incl. foundations)
Fence layout with coordinates
Security cabinet – details
Security cabinet – foundations
Security cabinet – cabling details
Specifications
Thermal camera
Keyboard, computer, monitor, server
Illuminator (IR)
Video encoder
Cables (optic-fibres, RS485, RS232, ...)
Ethernet switches
Other

11.3. Operation and Maintenance Manuals

O&M Manuals shall include the following:

- Facility O&M manual (general);
- Facility substation O&M manuals package;
- Module installation and maintenance manuals;
- Inverter O&M manual;
- Transformer O&M manual;
- Tracker and mounting structure maintenance manual;
- Switchgear maintenance manual;
- Procedures for verifying correct system operation;
- Procedure to be followed in case of a system failure;
- Emergency shutdown/isolation procedures;

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- Maintenance and cleaning recommendations;
- Health, safety and environment manual;
- SCADA O&M manual; and,
- Warranty documentation.

11.4. Other Documents

Other Documents shall include the following:

- Spare parts list;
- Lists and specifications for materials and accessories;
- Flash test reports for each single module;
- Manufacturer's warranty certificates;
- Quality assurance testing reports on the modules;
- Quality assurance testing reports on the inverters;
- Quality assurance testing reports on the transformers;
- Quality and test report for the rest of the materials and equipment (QA/QC);
- Earthing protection drawings and survey reports;
- Site electrical test reports;
- Component commissioning records in accordance with IEC62446;
- Certificates of compliance for all electrical buildings;
- IEC certificates of compliance for electrical components;
- Geological survey;
- Hydrological survey;
- Topographical survey;
- Chemical soil analysis; and
- Training programme.