



Annex 06 Owner's Requirements

MACAO Solar Installation

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1. INTRODUCTION

This document aims to define the minimum requirements for the detailed engineering, manufacturing, material supply, testing, packaging, delivery, assembly, installation and commissioning of the photovoltaic power plant “Macao” in Chile (“The Facilities”).

As general, the scope of works is for a Turnkey Full EPC of a Solar Photovoltaic Plant, falling under the PMGD category, including PV-Plant + Interconnection to the distribution grid.

Table below presents a summary of the Project:

Description	Information
Country:	Chile
Region:	TALAGANTE, TALAGANTE PROVINCE (METROPOLITAN REGIÓN)
Project Name:	MACAO
Project Design Life	25 years of Design Life
Project Area [Ha]:	17.85
UTM WGS 84 coordinates EAST:	See Annex 02 – SITE MAP
UTM WGS 84 coordinates NORTH:	See Annex 02 – SITE MAP
Altitude [m asl]:	350
Peak Power [kWp]:	10.08 MWp
Maximum AC Active Power at POI [MWac]:	9.00 MWac
Tracker / Racking system type:	Horizontal Single Axis Tracking
PV-Module Type:	c-Si / bifacial
Minimum PV-Module peak Power [Wp]:	440 Wp
PV-Module minimum warranty requirements:	Trina Solar Co. Ltd. Limited Warranty – Document PS-M-0135 Rev. O dated June 1 2020
POI power factor requirements:	As per Annex 05 – CONNECTION OFFER

This document provides the main characteristics of the equipment's and systems to be used in the PV plant. While it identifies the basic requirements of the Works under the scope of the EPC Contractor, it should be understood that the scope of work is not limited to that described in this document and is inclusive of all works required to engineer, construct and successfully commission and interconnect the Facilities to the local grid in accordance with Trina Solar's performance and design requirements, and with all applicable codes, regulations, local grid requirements and industry accepted standards and good practices.

The Facilities shall be designed to have a minimum 25 years useful life, considering the site specific conditions and expected operating conditions of the Facilities.

As detailed engineering is part of the EPC scope, the development design provided in Annex 08 is preliminary and for reference only. It is open for changes by the EPC Contractor, as long as these changes either imply improving or maintaining the same design quality. In any cases, Performance Warranty presented in Annex 18 shall be maintained.

2. DEFINITIONS

DEFINITIONS	
OWNER	Any person or company or designated representative by that has the property rights over the Facilities.
EPC CONTRACTOR = CONTRACTOR	Any person or company that directly or indirectly designs, performs engineering, obtains, installs, builds, tests and puts the owner's facilities into service.
SUBCONTRACTOR	Any person or company (other than the contractor or its affiliates) that perform some of the work on behalf of the contractor and / or supplying hardware project directly or indirectly to the contractor and its affiliates in connection with the operation of the construction site.
MANUFACTURER	Any person or company that is directly or indirectly responsible for the production of the required materials
SUPPLIER	Any person or company that is directly or indirectly responsible for the production of the required materials
DESIGN LIFE	The time when an element is expected to perform without repair. It means the O&M costs must remain the same year to year over that same time period.
OEM	OEM = Original Equipment Manufacturer

3. LEGISLATION AND CODES

The EPC contractor shall be fully responsible for ensuring compliance with local codes and regulations, as well as industry good practices. In particular, the following standards should comply with:

- **NORMA TÉCNICA DE CONEXIÓN Y OPERACIÓN DE PMGD EN INSTALACIONES DE MEDIA TENSIÓN**
- **NCh431-2010**
- **NCh 432-2010 Diseño estructural - cargas de viento**
- **NCh Elec 4/48**
- **NCH National Standards Area C and F**
- **All local applicable standards**

In addition with all international standards referred to in this document.

4. GENERAL REQUIREMENTS

The Work and Facility shall be designed, engineered, procured, constructed and delivered as "Turn-key".

The Work shall meet all the applicable prefecture, municipal, provincial, regional, national, and international codes, regulations, and standards, which may be amended, replaced, or supplemented from time to time, and which may be required by any governing authorities having jurisdiction (AHJ). A partial list of relevant standards, codes, and regulations are provided in Appendix A.

Where codes do not govern specific features of the equipment or system, equipment manufacturer specifications, industry standards and best practice shall apply.

Where local codes or ordinances will have an impact on the design, the EPC Contractor shall address these with the local authorities having jurisdiction, prior to completion.

Materials and equipment shall be labelled or listed by a nationally recognized testing laboratory, where deemed acceptable by the local utility, local electrical association, and the local authority having jurisdiction.

The Facility shall be designed to have a minimum design life of 25-years, considering the site specific conditions and expected operating conditions of the Facility; at any time during the performance of the Work, Owner reserves the right to request documentation to demonstrate the validity of the design life period.

Any part of the Facility that does not meet the minimum design life shall be clearly identified and the required maintenance regime shall be included in the Operations and Maintenance Manuals provided by the EPC Contractor; components forming the Plant shall be selected to minimize corrective maintenance events.

The EPC Contractor shall provide engineering drawings and reports signed, stamped, certified and/or sealed by a Professional Engineer, who is registered with the authority having jurisdiction, when required by applicable codes and/or regulations and/or as requested by the authorities, and with the appropriate engineering discipline of Geotechnical, Civil, Structural, Mechanical or Electrical;

The EPC Contractor shall be responsible for the overall management of the Work;

Design and Approval details the design documents that shall be submitted by the EPC Contractor for design review input and approval along with a submittal and approval tracking process.

EPC Contractor shall be responsible for all the required permits and associated fees related to the Facility and as defined in Annex 04.

If there are any requirements or specifications that appear to be in conflict, the more stringent shall apply.

4.1. LANGUAGE

All documentation regarding design, manufacturing, inspections, quality control, operation and maintenance shall be delivered in English and/or in the local language of the country where the project is located.

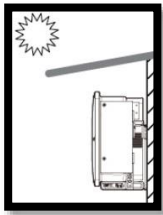
4.2. SCOPE OF WORKS

As general, the scope of works is for a Turnkey Full EPC of a Solar Photovoltaic Plant, falling under the PMGD category, including PV-Plant + Interconnection to the distribution grid.

The Scope of Works shall include, although not be limited to:

- Engineering of the Facilities
- Procurement of all equipment and materials required for the construction and entry in operation of the Facilities
- Electro-mechanical assembly of all Facilities' components
- Civil Works, including, but not limited to: Internal Roads, Access Road, Clearing and Site Preparation, Trenches, Fences, Dunes, Tree and rocks removal (if required), Demolition works (if required), Foundations and Drainage System
- All project engineering Interconnections integration between PV-Plant up and including POI
- All project document control
- Monitoring and control system
- Security system and security during the performance of the works
- O&M Buildings
- Warehouse buildings
- Wastes tank
- Dangerous materials waste tank
- Temporaries facilities buildings during construction, EPC Contractor & Final Owner
- Earthing and Lightning Rods systems
- Testing, Commissioning of the Facilities to ensure achieving Commercial Operation
- Internet (main and back up) lines as well as all necessary construction work to bring wired internet service to the plant
- Logistic to site management plan and all necessary work outside the plant to allow transport trucks access to site
- Project Management
- Permitting related to the construction phase and required for the entry in operation of the Project
- Health & Safety Management
- Quality Management and Document Control
- Environmental & Social Management as required for compliance with Project's Permits and commitments
- Bonds, Insurances and warranties
- Local authorities meeting and coordination as required
- Equipment's or systems design life calculations
- All (Plant+Interconnection) O&M manual and training for final owner/operator
- All necessary engineering studies for permitting and entry in operation, such as: Grid Impact Study, Harmonic Study, Grounding Study, Electromagnetic Study, Noise Study, Lightning Strikes Risk Assessment, PV-Panel reflection impact in the sky to meet local requirements, etc.

- Sounds suppression barriers (if necessary according Noise study approved by local authorities as applicable)
- Excavation, concrete pouring in first and second level and all civil works needed.
- Supply of high voltage cables, fiber optic cables, metallic structures, circuit breakers, disconnector switches, surge arrester, power transformer, rigid busbar, voltage and current transformers, medium voltage cabins, medium voltage cable, concrete, sand and gravel, perimetral fence, warning elements, aviation signaling, lightning protection, underground duct bank and concrete channel, underground flexible pipes, stockbridge or similar elements, fittings, fixations elements, bolts, nuts, washers, insulators string, connectors and clamps, terminal connection kit, operation platforms, SCADA and measurement system, high conductivity grease and all auxiliary elements needed for a full completion of the project.
- Capacitor bank (if applicable)
- Electrical HV filter at plant substation level (if applicable)
- Reinforcement, repair and maintenance of public or private roads affected during the development of the contract In particular, the contractor is reminded that any damage caused both to the work area and to the temporary access road shall be repaired and paid for by the contractor involved.
- Pre-commissioning, commissioning and start-up works for a complete energization.
- Factory certificates test, performance and quality, for each element supplied.
- Spare parts & tools supply for 2 year considering minimum 99% availability.
- Structure to install the AC Combiner Boxes and Inverters
- Sun protection roof for String Inverters



- Waste and storage structure container (As required PAS140)
- Waste container/structure for dangerous materials (As required PAS142)
- Plant Drainage system
- Drainage work outside the plant required by DGA (if applicable)
- All engineering work, basic – for construction & As-Built
- All required demolition work required inside plant
- All big object removal and site clearing
- Supply and Installation of all required Individual and collective protection devices, e.g.: Safety Kit for MV-Station & Buildings, Road signaling, Mechanical Interlocks, Safety locks, Safety stickers etc.
- Any required Low Voltage overhead lines to cross internal water channels or rivers
- Reception of equipment at site
- When required, design and construction of permanent bathroom and sewerage indicated in PAS permit

4.3. EQUIPMENT AND SYSTEMS DESIGN

The Project shall be designed for a design life continuous performance of its intended function under normal operating conditions at the Project's site assuming adequate maintenance will be performed and taking into account the local environmental and site conditions, including but not limited to, temperature, soil, flooding, dust, irradiation, grid conditions and altitude.

The EPC Contractor shall assess the area available at the Project site for development and installation of the Facilities and design the same in such way that the capacity measured at the Point of Interconnection ("POI") shall not exceed the Maximum AC Active Power defined in Annex 05 and fulfill all local grid code, local standards and utility requirements at any time.

The Project shall be designed so as to ensure that it can be decommissioned whilst not resulting in harm to the environment.

Grid Code Compliance shall be a requirement for commissioning and achieving Provisional Acceptance as described in the contract, and the Facilities shall comply with all applicable laws and will be fit in all respects for its intended purpose.

All elements should be designed or rated for the application, demonstrated by calculation, certification or specific test.

The Facilities' buildings shall be designed and constructed to withstand, without damage, all applicable environmental conditions as defined by applicable building codes for the Project site.

The systems shall be designed, using bifacial high quality c-Si PV modules from Tier-1 OEM as the basis for electricity generation.

The system 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.

All structural elements must be designed in accordance with local applicable codes.

All electrical equipment shall meet international and local specific requirements.

All materials and equipment shall be new with a quality reasonably expected in the international manufacturing and construction industries, free from defects and deficiencies of any kind. The works, equipment and any warranted component parts shall utilize proven technology that has been operated commercially at other locations and which will be capable of being insured either on the insurance market or by the EPC Contractor

The works shall be performed with all the skills and care to be expected from adequately qualified and experienced contractor and subcontractors with specific experience in performing the works and services required of a similar size, type, nature and complexity to the works.

All equipment installed outdoor at the Facilities must comply with UV protection and at least IP55 certification rated & designed for the maximum ambient temperature of the plant. Only MV-Station can have a lower IP rating of IP54.

All equipment should present a temperature rating design or calculation, especially the electrical panels installing outdoors and panels with high power concentration.

All engineering Works & design shall be individually and collectively certified by an adequate qualified independent engineer as compliant with local laws and regulations (i.e. Certificates of Compliance).

OEM recommendations are mandatory to comply with.

All selected equipment & parts must be designed for the application where is going to be installed, and size for the design life of the project. The EPC Contractor shall be able to present, upon request, manufacturer documentation that confirmed equipment is designed for the application & required design life.

In general, the EPC Contractor shall warrant that it shall use the state-of-the-art and most efficient technology in the performance of the Works and in respect of all Equipment, Contractor's Equipment, Major Components, Consumables, and all other materials and supplies utilized in connection with the Works.

5. SCOPE OF ENGINEERING

The EPC Contractor shall be responsible for all engineering and design activities related to the Project, including the related Interconnection.

The detailed engineering shall comply with the requirements of the applicable codes, standards, regulations and general specifications, and with the technical requirements contained in this Contract and Annexes.

In addition, it shall seek to achieve a high quality installation aiming to minimize downtimes.

Scope of detailed engineering includes:

- All Project Document Control, for all parts of the project: PV-Plant, elevation and interconnection Substations as well as interconnection Line and POI substation arrangement as applicable.
- All project Engineering Integration, including: Substations, Overhead Line, Inverters, PPC, Scada, CCTV, Weather Stations etc.

6. SCOPE OF WORK & SUPPLY

The EPC Contractor will be responsible for all the supply and assembly for the realization of the project. This includes everything related to the supply and assembly of the photovoltaic plant, interconnection and O&M spare parts.

In addition to the main equipment (modules, mounting system, inverters, MV stations, CCTV, Weather Stations, SCADA, PPC, etc), scope of supply shall include all equipment, materials and accessories, including but not limited to: cable, cables protections, fasteners, glands, electrical boxes, accessories, foundation, etc.:

Summary of the scope of work of the EPC Contactor:

- MV and LV Cables
- Control and communication cables
- Cable trays and conduits
- LV Distribution Panels
- Structure to install the AC Combiner Boxes and Inverters
- O&M building and its foundation
- Control System (All: From POI up to Inverter/PV-module level)
- Control and communications equipment at POI
- Weather Station (compatible with the chosen Monitoring and Control System)
- CCTV system
- UPS System (The capacity of the UPS must be calculated by the contractor), minimum time of 2 hour, for CCTV, protection and control system load
- Indoor Lighting and sockets
- Outdoor Lighting at gates, O&M Buildings & MV-Stations.
- Grounding system materials, installation (aerial and underground part, lighting rods, etc) and earthing resistivity study
- Lightning protection
- Final internet service (main & back up) for plant communication or equivalent solution (1 year service agreement from PAC, paid by contractor & transfer to final owner after 1 year)
- Fence
- Access road (from public road to the plant)
- Internal roads
- Temporary facilities for Contractor and Trina Solar
- Waste and storage structure container
- Waste container/structure for hazardous materials

- **PPC (Power Plant Controller)**
- **Permanent Internet service**
- **Permanent electrical auxiliary service**
- **Access road assessment and any reinforcement required to access the plant**
- **Civil design and construction work related to the access road**
- **Internet service for plant operation. Contractor must arrange all the paperwork, permits, diligences and installation to get internet in the plant**

6.1. PV MODULES

While there are several PV module technologies that the EPC Contractor may supply, including mono and poly c-Si, the PV modules shall meet, as a minimum requirements, warranty standards provided in Annex 12. In addition, the PV modules shall be selected among the Approved Manufacturers list provided in Annex 10.

Bifacial PV modules should be used. Modules of experimental or beta type are not allowed.

The photovoltaic modules must have a maximum positive power tolerance of + 5W. Negative tolerances are not acceptable.

The manufacturer must present the following information during tender process:

- **Number of bypass / bypass diodes (optional)**
- **Nominal Operating Cell Temperature (NOCT)**
- **Maximum Power / Peak (Pmax)**
- **Open circuit voltage (Voc)**
- **Maximum power voltage (Vmpp)**
- **Short-circuit current (Isc)**
- **Current in maximum power (Impp)**
- **Temperature coefficients**
- **I-V curves at the following irradiation levels; 1000, 800, 600, 400 and 200 W / m²**
- **OND file for PVSyst**

Specific Requirements for PV-Modules:

- **Mechanical performance up to 5400 Pa positive load and 2400 Pa negative load**
- **PV-Module should be framed minimum 35mm(1.38 inches) Anodized Aluminium Alloy**
- **Junction Box IP 68 rated**
- **Connector sealing cap. Connector shall be supplied with sealing cap**
- **PID Type PID Free, providing a Potential Induced Degradation (PID) free tests performed by reputable third party laboratories**
- **Performance warranty. Linear performance warranty. From the 2nd year to the 30th year.**
- **Certified laboratories. A list of certified/approved PV-Module test laboratories in LATAM, Europe and China to perform module test**
- **Output Power warranty. The pv-module manufacturer should present a table with the exact power value per year that is going to be valid (pass/fail criteria) when the customer check the module STC power in a certified laboratory. The laboratory STC power measurement uncertainties, accuracy, precision or error cannot be considered in the pass/fail criteria.**
- **PV-Module classification. Modules should be sorted by its Impp in at least 4 groups and labelled. Intervals should be agreed and approved by the Trinasolar Owners Engineering. Each shipping container should contain only one power and current with the exception of the shipment in the final 5 MW when different current bins are allowed in the same container, but separated at pallet level.**
- **TIER 1 Category only.**

- **FAT (Factory Acceptance Test).** The factory-leaving acceptance criteria of the module manufacturer shall be provided prior to any modules being dispatched from the point of manufacture
- **Module Handling Procedure.** A module handling plan covering all aspects of packing, transportation, reception on site, storage, and installation shall be in place
- **Flash Test.** The PV modules shall be flash tested at the factory of manufacture and these reports, data, and images (as applicable) are to be handed over to customer for acceptance prior to shipping of the modules.
- **Snail tracks free and free of defects** such as bubbles, delamination, EVA discoloration, burn marks, among others
- **The photovoltaic modules have to be, including but not limited to, under the certifications** ISO 9001, ISO 14001, IEC 61215, IEC 61730, UL 1703 and PV Cycle (or equivalent in each country).
- **The proposal should also refer to other certifications** (ex: heavy snow and ice charge, extreme winds, hail test, ammonia test, and salt corrosion tests) where appropriate.
- **The quality system of the manufacturer of photovoltaic modules must be certified according to ISO 9001, by an internationally recognized certification authority.**
- **The photovoltaic modules must be certified by Underwriters Laboratories (UL), TÜV Rheinland or by another recognized International Laboratory.**
- **IEC 61215/61730 / UL 1703 Certificates of photovoltaic modules by organizations listed on the IECCE home page.**
- **IEC61215/IEC61730/IEC61701/IEC62716/UL61730**
- **ISO14064: Greenhouse Gases Emissions Verification**
- **ISO45001: Occupational Health and Safety Management System**

EPC Contractor shall provide Owner with the following information for each module installed in electronic format (excel file):

- **Serial Number of each module**
- **Factory-measured module power, voltage and current data.**
- **Full flash test capacity.**
- **Copies of Quality Assurance and Quality Control documentation and/or data related to the module supplied by the Module Manufacturer.**
- **PV modules are to be supplied from any of the following suppliers (or any other approved by the Owner): Trina Solar or bankable Tier 1 module manufacturer.**

EPC Contractor shall install all modules in accordance with all applicable requirements of international electrical codes and the Module Manufacturer:

- **IEC 61853. Performance;**
- **SKL II. Safety Class II;**
- **CE mark;**
- **EN 50380: Datasheet and nameplate information for photovoltaic modules;**
- **IEC 60904: Photovoltaic devices;**
- **IEC 61215: Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval;**
- **IEC 61730: Photovoltaic (PV) module safety qualification;**

- IEC 61000: Electromagnetic compatibility (EMC); and IECTS 62804-1:2015: Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon.

6.2. MODULES MOUNTING SYSTEM

The mounting structures shall be selected among the Approved Manufacturers list provided in Annex 10.

EPC Contractor should consider 1 axis tracker as PV-Module Mounting System.

The PV module mounting system and foundations shall be designed to suite the specific geotechnical characteristics of the Project site.

Minimum requirements:

- The structure must be according to EN-ISO 146 in a quality level of 8.8, for the useful design life of the PV plant.
- The supporting structures must be compatible with the photovoltaic modules and must be approved by the module manufacturer previously.
- The minimum distance between the lowest part of the module and the ground, in any position or movement is 0.5 meters minimum.
- Compliance with all the specifications and materials.
- Protection against corrosion and galvanic coupling.
- Environmental category considered should be according UNE EN ISO 14173.
- Design and certified to all and latest IEC standards specific for PV Mounting system (Trackers)
- Design for free of corrosion for during design life period. Must be demonstrated by calculations.
- Equipotential bonding washer for module electrical continuity between structure and module frame is included, for example WEEB clamp type. PV-Module should be mounted and bonded to ground according manufacture installation manual and be certified for use with tracking system to UL-2703, UL-3703.
- All required structural and CIVIL engineer (stamped by local engineer if required) should be considered
- All local standards and required certification are mandatory to be complied.
- The structure must be designed to withstand the specific mechanical and chemical conditions of the site, for continuous operation, without any degradation of the material and without need of repair during the lifetime.
- The mounting bracket structure must have an appropriate permanent labels for quick identification during O&M

The structure calculation will take into account the data extracted from the hydrological and geotechnical studies referring to the characteristics and conditions of the ground.

During construction of racking, Contractor shall mark all bolted connections of racking structure after connections are tightened to torque value specified by racking manufacturer or Engineer of Record.

In case modules with different powers are installed, the EPC Contractor must be categorized by power in addition to maintaining a record through a mapping that reflects the exact location of the module, maintaining traceability with the drawings.

6.3. INVERTERS

The inverters shall be of the pure sine wave, commercial grade. In addition, the inverters shall be selected among the Approved Manufacturers list provided in Annex 10.

The materials and equipment used shall be designed, manufactured and tested in accordance with the following data:

- Service: Continuous
- Installation: Outdoor (only the Data Logger will be indoor)
- Minimum protection grade: IP 54 for outdoor equipment
- Minimum Corrosion protection Level: C3, according to ISO 12944

Equipment shall be designed for site maximum ambient temperatures.

The equipment to be supplied under this specification should be designed for the design life period, considering normal maintenance and corrosion, erosion and wear and tear of material.

The Supplier should define, where appropriate, the frequency and duration of main and intermediate stoppages for scheduled maintenance and indicate what is necessary to keep the equipment operating.

Inverter will be made by reputable manufacturers and will be suitable for 1500 Vdc.

The selected equipment shall be adequate for the climatic conditions of site working at full load.

The power factor value shall be adjustable from 0.8 lag to 0.8 lead and work continuously in 1, if it is necessary. Also, the inverters shall permit to change the and regulate the power factor, reactive/active power, start, stop, ratio ramp up and ramp down from the control system of the plant.

Inverter should be able to inject reactive power during night time.

The inverter will be able to communicate with the same standard communications protocol that has been chosen for the overall plant communication and control system. If the inverter needs an intermediate gateway to comply with this protocol, its installation, configuration and tests will be included in the scope of the Supplier, altogether with the supply of the *.gsd and mapping files that may be required.

Password protection will be provided to provide security against unauthorized parameter access.

At least, the following protections will be available:

Designation	
Unbalance voltage protection (%)	AC Overcurrent protection
Phase angle offset protection	PV-array String Fault Monitoring
10 minutes overvoltage protection (V)	DC-Reverse-polarity protection
10 minutes overvoltage protection (ms)	Anti-islanding protection
Level-N overvoltage protection (V/ms)	Input-side disconnect device
Level-N under voltage protection (V/ms)	Surge arrester in DC and AC side (Type I + II)
Over and under – frequency (Hz, ms)	

Overall Efficiency of the inverter shall include the inverter and all its auxiliaries (such as the cooling system), Output Sinus Filter, Power Factor Correction and Harmonic Filter (if any of the is applicable)

Inverter System efficiency calculations shall be in accordance with the latest international and restrictive standards.

Curve of efficiency is required for partial loads from 50% to 100% for the temperature ranges of the project.

The efficiency values shall be confirmed by the supplier at 100%, 75%, 50% and 25% of the load.

Inverters shall include the communication protocol indicated in the data sheet. The inverters shall connect to tablet or mobile display screen and visualize/modify all the parameters through USB data cable or Bluetooth module.

The Data Logger will provide monitoring and management of the PV power system. It will converge ports, converts protocols, collect and store data, and centrally monitor and maintain devices in the PV power system. The supplier is responsible for providing the adequate fittings to fix the Data Logger.

Inverter Manufacturer is responsible for designing, assembling and Factory Testing of all their equipment's (MV-Station, Inverters, Control System) according to: Local Utility Standards, Local Grid Code Requirements, Local Electrical Standards, Local Civil Standards, Local Safety Standards and with all applicable codes in the country. In case the inverter manufacturer do not provide MV-Station, they must validate the MV-Station solution.

The complete inverter solution (MV-Station, Inverters, Control System), will meet all the requirements of the Local Electric Grid Code, as: Minimum Response Time, Voltage Control, Power Factor Control, Reactive Power Control, Reactive Compensation at Night Time, The active power ramp rate, Frequency deviation response, Fault Ride Through, Voltage Ride Through, Dynamic Reactive Current Injection, Low/High Frequency Ride Through, Response Time and Error of Dynamic Reactive Current Injection, and any other requirement required by the Local Grid Code.

Inverter Manufacturer must submit FAT reports of all equipment prior delivery, in *.pdf format.

For Central Inverters, DC current measurement is required in each DC Inputs.

INVERTER POWER CONTROL FEATURES

- Active power curtailment included
- Active power ramp rate constraint included
- Reactive power close-loop control included
- Power factor close-loop control included
- Frequency Ride Through (FRT) capability included
- Voltage Ride Through (VRT) capability included
- Over frequency active power response included
- Reactive power injection for VRT included
- STATCOM mode: Reactive injection at night included. The inverter should be able to work in reactive power mode during the night (night time reactive power operation mode). The inverter should be able to automatically change from night time reactive power operation mode to day time operation mode without any local or remote intervention.

INVERTER MINIMUM RESPONSE TIME

- Maximum of 20 regulation loops per second, under any circumstance (Dynamic, Static, etc)
- Maximum scanning and refreshment speed of 1 second under any circumstance (Dynamic, Static, etc)
- Maximum delays time under any circumstance (Dynamic, Static, etc), as follow:
- Dedicated Power Line Communication (MBUS) is mandatory.
 - Transmission line delay (from data logger to all the inverters) should be less than 30 ms
 - Wider transmission bandwidth should be much over the inverter IGBT switching frequency (9 kHz ~ 18 kHz) to avoid interference from AC grid power. The bandwidth should be adjustable according to site conditions to improve the transmission quality.

- Baud Rate should be over 100 kbps.
- Support up to 40 modes/inverters per Data Logger
- Easy to maintenance, each inverter communication problem should not affect others inverters connected to the same data logger
- Power Line Communication (MBUS) should be third-party certificated.

INVERTER + PPC MINIMUM REQUIREMENTS

- UPS Backup system for backup. Minimum backup time is 2 hours.
- The minimum data storage capacity in the plant is one year.
- Rack to install all PPC devices
- PPC must include a Working Station (Display, keyboard etc)

INVERTER OPTIONAL CHARACTERISTICS THAT MUST BE INCLUDED

The inverter must include all optional characteristics, as:

- USB Key
- Compatible DC connectors for incoming cables
- Mounting clamps
- Portable display (if there is any)
- String monitoring software 2 years license (if there is any)
- O&M or monitoring application license, 2 years license (if there is any)
- 24/7 Remote & local technical service for O&M for 2 years.

6.4. MV-STATION

GENERAL CHARACTERISTICS

The Transformation Center considered must have the following characteristics:

- Nominal Power: According Inverters Power Curve
- MV Insulation: 10% above nominal continuous operation voltage
- Maximum voltage in continuous operation: $V_n \times 110\%$

It is divided into three compartments (sections):

- LV Panels. Equipped Key interlock as kirk-key or Ronin-key or equivalent
- Auxiliary transformer panel

MV SWITCHGEARS

- MV switchgears, SF6. Equipped with Key interlock as kirk-key or Ronin-key or equivalent
- MV switchgear medium voltage protection relay should be able to communicate by Modbus and send data to scada as: Voltage, Current, Trips, Local/Automatic mode
- Transformer Zone. Equipped with key interlock as kirk-key or Ronin-key or equivalent
- Electrical switch interlocking
- Mechanical switch interlocking with manual mechanisms
- Integrated leakage testing of the panels
- Breaker with motor capable of remote operations
- IAC AFLR Type or equivalent solution
- Vacuum circuit-breaker (only for V-panels)
- Two-position load break puffer switch
- Earthing switch with single spring operating mechanism
- Switch position indication for load break switches and earthing switches
- Single spring operating mechanism on cable switches
- Two-position mechanism with auto-reclosing duty for vacuum circuit-breaker
- Cable bushings with integrated voltage
- Operating handle
- Lifting lugs for easy handling

- Manometer for SF6 pressure
- Local/Remote selector
- Local/Remote signal integrated to scada

LV PANELS

The cabin will be composed of the following elements:

- Breakers
- Breakers must meet the short circuit level considering “infinite bar” on transformer MV bars
- Measurement and control equipment
- Surge arrester Type 1 + 2
- Key interlock as kirk-key or Ronin-key or equivalent
- Auxiliary services transformer power switch and UPS batteries
- Vcc power supply
- UPS with a minimum of 2 hours in operation for all control, CCTV and measurement devices connected to the stations
- Temperature control system with ventilation
- Moisture and condensation system (Condensation meter + Temperature sensor + Heater etc)
- Bender type insulation meter for systems with floating neutral
- Pilot lights for voltage presence at inputs and outputs of the panel

LV/MV TRANSFORMER

The transformation center will be composed of a power transformer with the following characteristics:

- Efficiency according latest version of EN 50588-1
- Transformer should be calculated for minimum of 7 hours at 100% capacity, 2 hours at 75%, and 2 hours at 50% every day for the design life period of the project. These are the minimum values, EPC Contractor is responsible to make their calculation to demonstrate transformer will support loading curve during project design live period.

Transformer mandatory accessories

- Gas accumulation alarm: 1 pcs
- Flow of oil trip: 2 pcs
- Oil temperature alarm: 1 pcs
- Oil temperature trip: 2 pcs
- Oil temperature signal: 1 pcs
- Pressure relief trip: 2 pcs
- High oil level alarm: 1 pcs
- Low oil level alarm: 1 pcs
- In addition, the MV Stations shall be selected among the Approved Manufacturers list provided in Annex 10.

ADDITIONAL CHARACTERISTICS FOR MV-STATIONS

- The transformer and the building must be of type C4 (degree of atmospheric protection)
- MV station that connect directly to substation must be CCV Type, the rest (downstream) could be DV type
- Include repainting kit for possible defects during transport.
- The transformer connection and LV board is mandatory in bars (cables are not accepted)
- LV cable entries must include hardware to secure the cable terminals that come from the inverter.
- LV input terminals or bars must be sized to withstand the nominal current at 90° C in permanent mode (100% rating)

- Proof of sizing of bars must be delivered
- Thermal analysis of the solution and dimensioning of the building's cooling system, LV frame and MV cell cubicle must be delivered.
- Dry transformer is not accepted, must be outdoor oil type
- Must include oil collection tank and oil filters. Oil tank could be built outside the station.
- The signals of the transformer devices must reach a terminal box that is already pre-wired by the transformer manufacturer.
- All transformer devices must include “duplicate” signals, some for cell tripping and others for integration into the SCADA.
- The transformer must include a voltage arrester in the MV side.
- MV-Station will be prepared/designed to work at 10% above of the Nominal Medium Voltage in continuous permanent conditions.
- All Transformer and MV-RMU must be prewired to an Input Card (signal concentration unit), that will allow integration by ETHERNET cable

6.5. CABLES

All cables should come with a letter from the manufacturer indicating the design life, considering the installation conditions (depend on each cable), for example: Outdoor with direct sun light in continuous operation for string cables, Direct Buried or Direct, Buried in water saturated soil, etc.

String DC Cables

- Must be designed for the application
- String cables must meet IEC 62930 or an equivalent standard that must be specific for PV applications and valid for the plant local requirements.
- Insulation should be 1.5/1.5 kVdc minimum (Phase to ground insulation must be 1,5kVdc)
- Minimum AD07 Water protection or equivalent
- Cable should have minimum 2 layers, 1 for insulation and 1 for jacket.
- Is local code allow it, preferably EPC contractor should use black color cables for string cabling
- Typical sizes are: 6 mm² & 10 mm²

DC Cables for combiner boxes to Central Inverter

- Must be designed for the application
- Insulation should be 1.5/1.5 kVdc minimum (Phase to ground insulation must be 1,5kVdc)
- Minimum AD08 Water protection or equivalent
- Suitable, tested and warrantied for direct buried
- Cable should have minimum 2 layers, 1 for insulation and 1 for jacket.
- Is local code allow it, preferably EPC contractor should use black coloured cables for string cabling
- Typical sizes are: 150 mm², 185 mm² & 240 mm² & 300 mm²

AC Cables for string inverters

- Must be designed for the application
- Insulation should be 1.0/1.0 kVac minimum (Phase to ground insulation must be 1,0 kVac)
- Minimum AD08 Water protection or equivalent
- Suitable, tested and warrantied for direct buried
- Cable should have minimum 2 layers, 1 for insulation and 1 for jacket.
- If local code allow it, preferably EPC contractor should use black coloured cables for string cabling
- Typical sizes are: 150 mm², 185 mm² & 240 mm² & 300 mm²

MV Cables for combiner boxes to Central Inverter

- Must be designed for the application
- Insulation should be minimum 10% above nominal operation voltage
- Minimum AD08 Water protection or equivalent
- Suitable, tested and warrantied for direct buried

- Should have radial and longitudinal protection against water penetration
- Typical sizes are above 150 mm².

Fiber optic & communication cable

- Must be designed for the application
- Minimum AD08 Water protection or equivalent
- Suitable, tested and warranted for direct buried
- Armoured cable or equivalent solution
- All power, control and instrumentation cables shall be flame retardant, according to IEC 60332-3, IEC 60754 and IEC 60331.
- Design requirement for fiber optic circuits is redundant. This is achieved through a ring configuration. With this configuration, there are two possible data communication paths to reach each MV-Station.
- Fiber optic should be design for 50% spare fibers
- Copper type communication cables should be double shielded

6.6. IN-FIELD EQUIPMENT ENCLOSURES

- Enclosures are to be designed to withstand the site specific environmental conditions for the lifetime of the Facility.
- The minimum warranty shall be 5 years.
- Enclosures are to be UV rated or protected from exposure to the sun.
- Enclosures are to have a minimum IP rating of at least IP54.
- Enclosures shall employ ventilation lugs to prevent condensation build-up.
- Enclosure should have anti condensation valves.
- Enclosure should have drain valves.
- Enclosures are to have surge protection installed on the power and communication circuits in accordance with the Lightning Protection System design.
- Enclosure doors shall be hinged and lockable with a standard electric cabinet key.
- Enclosure should be lockable by external lock
- Outdoor enclosure should have a mini roof to reduce sun light heating
- All panel must have a Heat/temperature calculation report and all components should be able to work at the expected temperature inside the cabinet. Heat calculation must consider sun light heating.

6.7. GROUNDING

Grounding designs are to comply with relevant codes taking into account the results of the Geotechnical Study such as the ground resistivity tests and any other tests required.

Grounding cables are to be copper if bare and green & yellow if insulated.

The works shall provide for a fully protected robust grounding system. The design shall adhere to the engineering standards appropriate for the project.

6.8. ELECTRICAL PROTECTION

Disconnects (fuses, isolators, circuit breakers, etc.) shall be coordinated (internally and externally with regards to the Project facility) and designed based on fault current ratings of components.

A suitable load break switch dis-connector must be installed at the inverters DC input The switch will be readily and easily accessible.

In case Combiner Boxes are installed, suitable load break switch dis-connectors must be installed at each combiner box to enable isolation at the sub-array level. The switch should be installed in such a way to be operated from the outside of the combiner box and that the enclosure maintains all specifications detailed herein

The switch disconnector 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.

The switch must be labelled as 'PV array DC isolator', with the ON and OFF positions clearly marked. Switch enclosures should also be labelled with 'Danger - contains live parts during daylight'.

All labels must be clear, easily visible, constructed and affixed so as to last and remain legible for the entire lifetime of the Project.

Protection systems shall disconnect the Project to minimize damage from faults. Main and backup or dual protection schemes shall be installed using modern protection relays.

6.9. WEATHER STATION

The weather stations shall be spread out across the Project site in a way that irradiance monitoring is performed in the most representative manner of the full PV plant.

The weather stations shall operate independently of auxiliary supply for a period of up to 48 consecutive hours.

The minimum amount of sensors to be installed at the project is as follow:

- 2x plane of array pyranometer (ISO 9060 spectrally flat Class A)
- 1x horizontal pyranometer (ISO 9060 spectrally flat Class A)
- 1x ambient temperature sensor
- 2x module temperature sensor
- 1x wind director sensor
- 1x anemometer (wind speed sensor)
- 1x precipitation sensor
- 1x soiling measurement device allowing monitoring of soiling factor as per IEC 61724-1

All sensors shall be connected to the Project Supervisory Control and Data Acquisition (SCADA) system.

An effective and appropriately specified lightning detection and warning system must be provided at the operations complex.

For the avoidance of doubt, weather stations shall be protected against the effects of lightning activity, if applicable.

6.10. CONTROL SYSTEM

The contractor will supply equipment or services meeting the following minimum specifications:

- Remote control system development in the customer center system, monitoring the following elements:
 - Substation main components
 - Inverters
 - AC counters as inverters
 - DC counters as inverters
 - Remote inputs / outputs

- Transformer protection system
- Weather stations
- Calibrated cells independent of weather stations
- Followers / Trackers
- Device active power control of the plant.

The system should include monitoring screens, variables, alarms, reports, user settings and permissions. Users should be able to access the system using a standard interface and is based on Java and HTML5 browser.

Screens to develop:

- General screen plant
- General screen counters AC
- General screen counters DC
- General screen INVERTERS
- General screen Trackers
- Screen view of each transformer
- Screen weather stations and cells Calibrated
- Screen transformer protection system
- Screen view substation
- PPC screen view
- SLD display medium voltage
- Charts and graphics display
- Reports display counters production
- Screen plant performance reports (PR)
- Events linked to the production system
- Alarm management via email

Reports to be generated (at least):

- **Meter Production Report:** should reflect the energy generated by each meter for the selected time period. The sum of the AC meters, the value of the MT meter, calculating transformation and transport losses will be included.
- **Report PR (Performance Ratio):** this report reflect the PR for each AC meter for the selected time period, the PR for the sum meter AC in each line, report PR referenced to the measured MT and a global PR of ground referenced to the sum meter MT.
- **He availability report:** show the calculation of the availability of each string, inverter and follower. The calculation should be based on the number of hours that said string, or follower inverter has been operating in a particular time period. This report should be based on criteria established by TRINA SOLAR availability.

All reports must include in their head: date and time of the system, data start and end of the selected time range. Likewise, it includes a brief description of each report.

Alarms to be generated (at least):

- Alarms generated by the monitored elements.
- Alarms calculated (zero production strings open circuit, deviations in the inclination of followers, position of the followers with strong winds, misfields meteorological towers, failure sensors of the meteorological towers by comparison with reference values , network control, high temperature equipment, production below average ...).
- Alarms generated by communication failures.

The preferred supplier for the control of power plant is Green Power Monitor or Meteocontrol.

It is proposed the implementation of a system that allows to achieve the reduction of operating and management costs by developing the following aspects:

- Improvement in the maintenance of the installation, surveillance systems, preventive, predictive and corrective maintenance.
- Automated prediction system. Decrease penalties for production deviations.
- Global plant control system. Decreases the cost of operation.
- Automated management system. Reduces the costs of the management processes (billing, accounting, taxation, etc)
- With the monitoring system that is proposed, we achieve:
- Reduction of installation costs.
- Improvement of the installation efficiency.
- Decrease in operating costs.

In the O&M building will be located a Rack in which the Server will be included, Switch of interconnection of Fiber optic with the plant FV, UPS with (designed for 1 hour) and the router that will connect to the router of access to Internet (in the contractor scope).

The system must include the Energy Meter, Reconnector, Breaker reading at POI.

The Control System shall be Green Power Monitoring or Meteocontrol

In order to optimize the cost and performance of the photovoltaic solar plant, the monitoring system that is proposed consists of the following:

- Work to establish Internet service to the plant. Service contract to be signed by Trina Solar.
- Weather Station (having all sensors calibrated).
- Monitoring of electrical parameters of each Smart String Inverter.
- Data-Logger Team (supplied by Trina Solar).
- Reading of Energy Meter and Reconnector at POI.
- Supervisor of protections and systems. Equipment that monitors the status of low voltage and medium voltage protections.

The Control system incorporates the control system of the Facility and the interface with the grid operator. Facility operation points (for power factor, of voltage level) shall be remotely set-up by the grid operator through the RTU communication system. The control system of the Facility shall incorporate the control processes to maintain the appropriate settings during operation, by remote control of the inverters and MV switchgear equipment.

The time for the whole system shall be done with a GPS to avoid any time lag. The connection between the different devices (inverters, network analyzers, weather station, etc.) and the Server will be made by the contractor through the local network of the installation, using switches to group equipment.). The devices to local network will be interconnected forming a virtual fiber optic ring. The transition of the field buses (eg Modbus RS-485) to the local network (Ethernet TCP / IP) will be done through a suitable gateway (protocol converter). The connection between the Server and the external database is made over the Internet. Therefore, a permanent connection to the Internet is required at the control center.

The different equipment that make up the solar plant (inverters, analyzers, weather station, strings monitors, etc.) use different types of networks and industrial field buses (Modbus, Profibus, DeviceNet, etc.) and communication protocols (RS-232, RS-485, RS-422, etc). By installing the appropriate gateways and switches, a local network is configured in the plant to work with a standard protocol (Ethernet under TCP / IP). In terms of field buses, an open protocol and RS-485 or similar (shielded to the pair and the whole) will be used at the physical level, since it is the most

widespread solution in instrumentation. The buses must incorporate signal amplifiers and gateways to other media (Ethernet cable or fiber optic).

Each device in the network must have assigned a fixed and univocal IP within the same range, so that the Server can access any device at any time. The Server must have a permanent connection to the Internet, through an ADSL or satellite router, depending on the availability of the service at the plant's location. A redundant additional connection can be included (for example, by 3G or GSM modem), to guarantee the continuity of the data transfer in case of failure of the main connection.

The Server acts as a master in the local network and the devices as slaves. This means that the Server requests a value from a record to a specific team and it responds with the requested data. However, if an alarm or fault occurs, the slave unit immediately sends a message to the master PC.

The information can be consulted at anytime and anywhere through the website, from any device (computer, mobile, etc.). The web platform has been developed in PHP with some Flash plugins.

6.11. GRID CONNECTION

The facility interconnection shall be capable of exporting the full contracted capacity and reactive power as may be required within the limitations of the grid code.

The interconnection shall be designed in accordance with all relevant codes and shall comply with the distribution company requirements and project's permits.

The facility shall be grid code compliant under all normal operating conditions and under the range of conditions specified by the local Grid Code.

The EPC Contractor will be responsible for all engineering coordination of the facilities interconnection.

6.12. SECURITY & CCTV

SECURITY

As priority fence must meet requirements described in the permits

A security fence should be installed around the entire perimeter of the Project site with the following characteristics, as minimum:

- Should be design for corrosion free for design life period
- Fencing must be cyclonic mesh wire cloth hot dip galvanized gauge # 10.5 with rhombic opening 63 x 63 mm with tolerance of + - 3mm.
- Tubular hot galvanized (inside and outside) diameter 1 7/8 " with foil gauge # 18 and total length of 2.40 m.
- Tubes and support structures must be compatible with access doors and gates.
- Setting maximum height: according to customer specifications.
- Passageways for small fauna to 100 m.
- Compliance with all materials and specifications.
- Protected against corrosion and galvanic coupling throughout the warranty period.
- The screws should be cadmium (electrolytic protection).
- Environmental classification EN ISO 14173.
- Concrete foundation with each of the posts and corner fencing.
- Horizontal retained and tensioners are used for high corner posts.

Fence gates should allow trucks and heavy machinery access.

Fence gates should have outdoor lights with movement's sensors

Fence gates should have open/close sensor to know the status of the gate

CCTV

Outdoor rated thermal security cameras and receiver with recordable capabilities shall be installed to provide surveillance of the Facility for remote monitoring of the Facility from the control room. Thermal cameras shall be installed along the whole perimeter of the Facility such that no "blind spots" exist. This video surveillance system shall employ cameras controlled by the hardware and software platform located in the control building. Security related panels shall be located in the control building. Doms shall be positioned at entrances to ensure that the complete entrance area can be monitored. Access Control shall be installed at the main entrance of the Facility. Ethernet FO cable in underground conduit shall be installed from the camera to the control room. The system shall incorporate a fence enclosing the entire perimeter of the Facility. All the devices of the security system shall be supplied by the auxiliary system.

Post location should not generate shadows on PV-Panel. Shadows on PV-modules should be reduced as the minimum possible.

The plant's security system should be design to cover the entire fence area, without any blind spot and, the fulfillment of the following items:

- **The system will consist of thermal vision and night vision cameras.**
- **The system should be prepare to work with a "ACR" (Alarms Central Receptor)**
- **The system should be able to storage all CCTV data (videos, alarms, events, etc.) in the plant servers for minimum 31 days.**
- **The system should include "Outdoor UPS Cabinets" for cameras energy back up system. UPS system sized to provide backup power for up to 2 hours in case of a power failure.**
- **The system should able to be integrated with the Plant Control system, CCTV System status and alarms should be able to be read using MODBUS protocol by ETHERENET TCP-IP Cable.**
- **Outside O&M building, the following camera must be installed, Exterior type Wifi FULL HD Safire VINOLO or equivalent**
- **Door status detector should be installed in all buildings**
- **Inside O&M buildings volumetric detectors & motion detectors should be installed**
- **Inside O&M building a camera should be installed to watch all sensitive equipment's**
- **The Security System shall include alarm capability; the system must have the capability of sending security alarms by email to the remote centralized control room or 3rd party monitoring company.**
- **The IR sensor should allow 100 m of night time viewing capability.**
- **Perimeter will be equipped with IP thermal cameras with its associated video analyzer to complete the CCTV system for video analysis. Thermal cameras shall be installed along the whole perimeter of the PV Plant such that no "blind spots" exist.**
- **Furthermore, CCTV should have dome cameras, for an overview of the PV system. This system will be associated with the CCTV system in order to monitor alarms with these cameras.**

The intelligent perimeter security is based on having a vision and capture of images (video) at all times and of the entire perimeter of the enclosure. Not only does it allow real-time intrusion detection, but it also detects the intruder before accessing the premises, generating a warning. This is achieved by processing and analyzing all the videos generated by each and every one of the cameras.

The security system of the devices described below, all of them integrated into a single system that aims to achieve reliable and robust protection.

The system should be capable to be integrated in the Control System and possibility of alarm reading through communications protocols as MODBUS

RECORDERS

32-channel recorders DAHUA-157 / NVR4832. They have the following characteristics:

- Fully stable LINUX embedded operating system
- H.264 video encoding and G.711 audio
- Two-way PC / DVR audio conversation
- Simultaneous playback of 16 channels in real time
- Includes remote control and USB mouse
- Remote keyboard control (Joystick) via TCP / IP or RS485
- Independent configurable video sensor per camera
- Multi-language display configuration menu
- Dome control in RS485 multiprotocol
- USB ports for external devices
- Software and hardware watchdog
- Watermark to preserve the integrity of videos
- User access to cameras in local and / or remote mode
- Several IP cameras can be updated from the NVR at the same time
- Masking areas, video loss alarm and camera concealment
- Vision, configuration and remote control by TCP / IP with client program and Internet Explorer browser (compatible with Firefox and Chrome browsers)
- Sending emails with attached photo in alarm
- Sending to FTP scheduled or on alarm
- Alarm sending, and connection to video surveillance receiver
- Display on Symbian, Blackberry, Windows Mobile, Android and iPhone smartphones
- Fixed / dynamic IP via DynDNS, NoIP, DDNS Evolution, etc.

SUPPORT FOR SECURITY STAFF

In case of detection of an incident, the system notifies the security guard. This allows a quick preventive action.

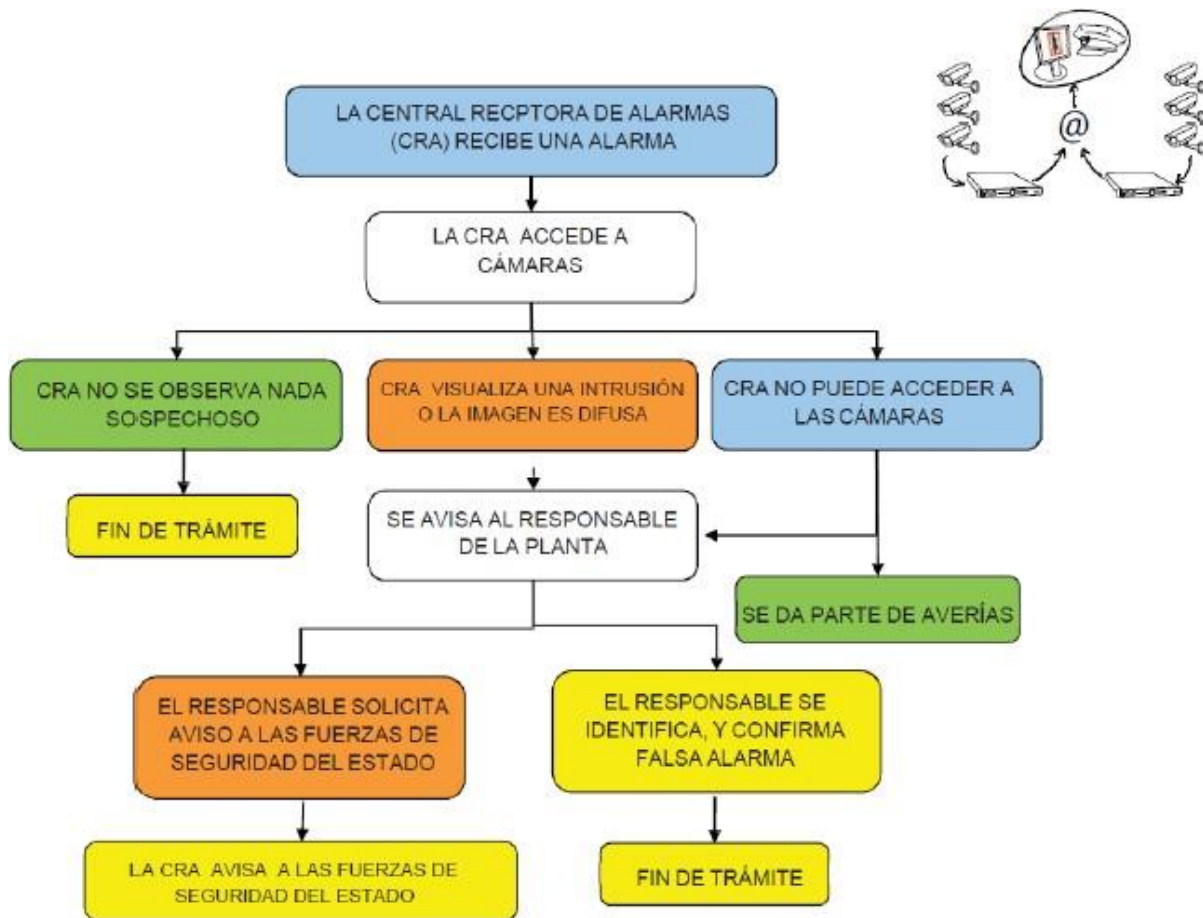
Supervision from an alarm receiving station (CRA)

If the plant does not have security guards, alerts are sent to the Alarm Receiving Center, via Internet connection.

If there is a detection, the system sends an alarm to the CRA and this alerts the operator, who activates the security protocol. In case of intrusion, the CRA can remotely activate deterrent measures (sirens, lights, etc.).

The video analysis systems of the plant have integrated verification systems. This allows the CRA to filter out "false alarms", and thus not unnecessarily disturb the customer.

The treatment of an alarm received thanks to a video system is carried out according to the following scheme:



6.13. OVERHEAD LINES

The scope of this section is to provide minimum requirements for major AC Overhead collection system components as they shall be supplied by the EPC contractor.

Contractor shall ensure that the collection system complies with all requirements of any governing authorities having jurisdiction.

The following are the minimum requirements for OH Line:

Power cables: shall consists of a solid or stranded steel core surrounded by strands of aluminium. The aluminium shall has a shiny surface which a low emissivity for heat radiation and a low absorption of sunlight. The steel core shall be galvanized steel with 5-10% of zinc. The aluminium alloy and temper used for wires shall be greater than 99.5%, guaranteeing a maximum working temperature of 75 °C without deformation. The cable used by the contractor shall comply with all requirements indicated in the project.

Fiber optic cables: The optical fiber cable shall be built with the purpose of grounding and atmospheric discharges in aerial installation, the working temperature shall be between -40 °C and 70 °C without suffering deformations, it shall have a central dielectric element, with a wire to block water penetrations, the optical fibers will be of single mode type with independent tubes for each 8 fibers at most, the protection tube will be built in aluminum, finally the cable will be

covered by steel wires covered with aluminum. The cable used by the contractor shall comply with all requirements indicated in the project.

Conversion box OPGW-FQ: The converter box shall be made of aluminium alloy with high mechanical resistance and strong corrosion resistance, suitable for outdoor installation, it shall include the necessary fixings for mounting on the tower, the cable entry shall always be from the bottom and by means of cable glands, the size shall be suitable for connecting all the fibres according to the project indications. The box used by the contractor shall comply with all requirements indicated in the project.

Fittings: The fittings shall be made of hot-dip galvanized steel, with high mechanical resistance and strong corrosion resistance, suitable for outdoor installation, with enough mechanical resistance. The fittings used by the contractor shall comply with all requirements indicated in the project.

Insulator string: The insulator chains shall be formed by glass or composite insulators, offering the highest mechanical resistance and leakage line, with high mechanical resistance and strong corrosion resistance, suitable for outdoor installation, they shall have a profile that favours the self-cleaning of the insulator. The insulators used by the contractor shall comply with all requirements indicated in the project.

6.14. CIVIL ENGINEERING AND CONSTRUCTION REQUIREMENTS

The scope of this section is to provide is to state the civil engineering design requirements.

CIVIL design should be according project design life period.

The civil engineering design shall be conducted or directly supervised by a professional engineer licensed by the local government or organization where the Site is located.

CIVIL DESIGN CRITERIA:

- EPC Contractor shall adhere with all planning permissions and land lease agreements, when applicable.
- Design shall be adequate to install and operate the Facility based for its intended use.
- Design shall include a site preparation plan.
- Graded areas, where required, shall be smoothed and compacted, and shall be in accordance with tracker supplier's specifications and tolerances.
- Hydrological survey and drainage system shall define the requirements for the protection of electrical equipment against flooding and road and other PV structures against erosion;
- Maximum surface slope for PV array areas shall be in accordance with tracker supplier's specifications and tolerances.
- Final grade adjacent to equipment and buildings shall be at least 150mm below the finished top slab or bottom of structure as applicable and shall be sloped away from the slab, equipment, or building at a minimum of 2% slope.
- Roads shall be designed to comply with all applicable emergency and fire regulations, including width, turning radii, and road structural sections.
- Roads accessing the entire site for equipment delivery, installation, construction and O&M work.
- All underground utilities (conduits, cables, duct bank, etc.), shall have adequate protection to prevent damage at all road and path crossings.

- Contractor shall perform a road condition survey of the existing Access Road before and after construction. If damage is found along the Access Road between the
- Cable trenches ground compaction minimum value should be 90%
- For cable trenches, as minimum requirement Direct buried conductors or cables shall be installed so that they run adjacent to each other and do not cross over each other and with a layer of 6 mm (nominal) screened sand or screened earth at least 75 mm deep both above and below the conductors. screened earth of 1mm (screening mesh N°10-20 0.85-2.0 mm)
- For cable trenches, backfill containing large rock, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where such materials may damage cables, raceways, or other substructures, prevent adequate compaction of fill, or contribute to corrosion of cables, raceways, or other substructures.
- Trenches close to mounting (tracker or racking) structure should be validate it by mounting structure manufacture to ensure do not affect piles/foundation structural integrity.

Inspection and Testing

- The Engineer of Record, or their representative, shall perform inspection and testing for all stages of the civil construction work to verify compliance of the work with the law and requirements of the Authority having jurisdiction, the recommendations from geotechnical report, topography report and/or manufacture's specifications.
- All the field and laboratory testing shall be prepared and achieved in a manner readily available to the job site. Reports shall indicate the date and time when the work was conducted and testing completed, and the Owner's Inspector name and signature.
- Any nonconforming conditions detected which are by the Contractor shall be documented in a written report submitted to the Owner for disposition.

7. EQUIPMENT WARRANTIES REQUIREMENTS

According to Annex 12.

8. SPARE PARTS

According to Annex 13.

9. QUALITY

Contractor shall be responsible for and prepare a Quality Assurance Plan in accordance with the provisions set out in this Contract, its Annexes, the Applicable Law and Applicable Permits. The Quality Assurance Plan and Manual shall apply to the entirety of the Works and shall be Project specific.

10. COMMISSIONING

The Contractor shall undertake, at its responsibility and cost, all pre-commissioning, Cold and Hot Commissioning activities, and any other tests necessary to demonstrate the quality and reliability of the Project conforming to the Project Documents, the Contract, the applicable norms, and any applicable national and international law and standard, as well as the Grid Operator requirements.

Commissioning and testing of the Works is under responsibility of the Contractor and any cost or expenses incurred in carrying out the commissioning and testing shall be borne by the Contractor unless otherwise stated in the Contract or agreed between the Parties.

The Contractor's commissioning tests procedures shall comply with the requirements provided in Annex 15.

11. PERFORMANCE RATIO

EPC Contractor guarantees that the Actual Performance Ratio will meet or exceed the Guaranteed Performance Ratio as per their definition in Annex 18, for both the Provisional, Intermediate (1 year following Provisional Acceptance) and Final (2 years following Provisional Acceptance) Acceptance Performance Tests (altogether the “Performance Guarantee Tests”). Procedure for calculating Performance Ratio is provided in Annex 16.

12. PERMITS SCOPE

The EPC Contractor shall be familiar with all relevant local permit requirements and shall be responsible for obtaining all permits necessary for the Works, besides those obtained by the Project Company (the “Owner’s Permits”, as provided in Annex 04). The Contractor shall be responsible for obtaining and maintain all the Contractor’s Permits, as defined in Annex 04. The Contractor shall work in accordance with the legal requirements and all applicable laws and codes. The Contractor shall adhere to all applicable utility requirements, standard practice, laws and regulations, including labour standards.

The Contractor’s design should comply with all Owner’s Permits provided in Annex 04.

13. PROJECT DOCUMENTATION

The EPC Contractor shall prepare all required documentation and manuals according to Annex 09.