pv plant

Miohammad Parhamfar

Titles

Project Development
Introduction Garghoyeh project
Central and Decentral Inverter
Surveying layout and SLD maps
Mechanical equipment
Surveying project pictures
Earthing and Lightning
Test and certificates
Questions

Project Development Stages

Stage1-Site identification/concept
Stage2-Pre feasibility study
Stage3-Feasibility study
Stage4-Financing/Contracts
Stage5-Detailed Design
Stage6-Construction
Stage7-Commissioning

Site Identification

Identification of potential site(s)
Funding of project development
Development of rough technical concept

Site Identification

The concept development stage includes identification of the **investmet opportunity** at a **specific site** and the formulation of a strategy for project development It is assumed at this stage that a target market has been identified and the project developer

understands any special prerequisites for investing in that specific country and power sector. These market-level decisions require a detailed assessment that carefully considers the risk–reward appetite of the project developer and potential investors

Site Identification

A desirable site has favorable local climate, good solar resource (irradiation), land available for purchasing or long-term leasing, an accessible grid connection or a binding regulatory commitment to connect the site to the transmission network, and no serious environmental or social concerns associated with the development of a PV project. Many countries require that the site be part of a list pre-approved by the government; this needs to be confirmed at the outset of the site identification process.

Site Identification

At least a preliminary (conceptual) design should be developed that helps estimate installed capacity or megawatts (MW), expectations, approximate investment requirements, energy yield, expected tariff and associated revenue. This way, a preliminary assessment of costs and benefits can be made, including return on investment(ROI). A preliminary financial model is often developed at this stage .

Site Identification

OUTLINE OF PROJECT STRUCTURE

a developer may not be ready to invest significant resources, and may leave the project However, it is important to think about structuring issues at an early stage. In emerging markets, the formation of a project company can be challenging .International developers/investors will need to carefully consider such requirements, as well as any potential concerns about taxes and repatriation of profits. If a developer is exploring a portfolio of opportunities in a new market, it may be worthwhile to establish or purchase a Special Purpose Vehicle (SPV) that can be utilized when a project moves towards development

Site Identification

THE REGULATORY FRAMEWORK AND SUPPORT MECHANISMS

Many countries set strict criteria for new renewable projects to qualify for financial support. Such criteria for solar PV will vary by country and may also differ based on project size (i.e., commercial rooftop solar versus projects over 1 or 5 MW). Also, actual financial support may vary for peak and off-peak hours. Developers need to understand the regulatory requirements for qualifying for financial support in order to secure the highest available tariff and, critically, must be acutely aware of cut-off dates for particular support mechanisms. Failure to understand support mechanism rules and regulatory dynamics could result in a significant loss of revenue and have a negative impact on project economics,

Site Identification
OFF-TAKER DUE DILIGENCE

What is an 'Off taker Agreement'

An off taker agreement is an agreement between a producer of a resource and a buyer of a resource to purchase or sell portions of the producer's future production. If lenders can see the company has a purchaser of its production, it makes it easier to obtain financing to construct a facility.

Site Identification
OFF-TAKER DUE DILIGENCE

Credit-worthiness of the off-taker is critical and should be a primary focus of the due diligence to determine the level of risk associated with a PPA. As a legal contract between the solar plant operator and the purchaser of the electricity produced, a PPA defines future project revenues

Due diligence is an investigation of a business or signing a contract, or an act with a certain standard of care

Site Identification

FINANCING STRATEGY

The concept stage is an iterative process that aims to develop an understanding of the risk, project-specific costs and revenues that enable an assessment of project economics. The developer's objective is to obtain sufficient information to make an informed decision about the probability that the project can be taken forward. If the project looks promising, the developer is likely to decide to proceed to the next stage.

Concept stage Checklist

Concept Stage Checklist

The checklist below covers key questions and factors the developer should consider when deciding whether to proceed to the next stage, which is to conduct a prefeasibility study.

- ☐ Project structure outlined.
- ☐ Does the country and power sector provide adequate risk-reward benefits to private investors?
- ☐ Regulatory support and tariffs, especially the duration and timeline for any incentives for solar power.
- ☐ Suitable site identified taking account of site constraints.
- ☐ Grid access (proximity, capacity, and policy provisions for access).
- ☐ Appropriate funds available to carry out the feasibility assessments.
- ☐ Identification of off-taker and available infrastructure to take the power generated.

STAGE 2 – PREFEASIBILITY STUDY

The aim of a prefeasibility study is to develop a preliminary plant design and investment requirements, which allow further assessment of the financial viability of a project. This assessment involves more detail than the previous stage.

Pre feasibility study

Assessment of different technical options
Approximate cost/benefits
Permitting needs
Market assessment

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STAGE 2 – PREFEASIBILITY STUDY

- The project site and boundary area, ensuring access to the site is possible, both legally and technically.
- The approximate costs for land, equipment, development, construction and operation of the project, as well as predicted revenue
- The anticipated electricity tariff to be received based on market analysis in a market

STAGE 2 – PREFEASIBILITY STUDY

- A financial model to determine the commercial viability of the project for further investment purposes.

- Grid connection cost and likelihood of achieving a connection within the required timeline.

- Identification of key environmental and social considerations and other potential "deal-breakers."
- Permitting requirements, costs, and likelihood of achieving consent.

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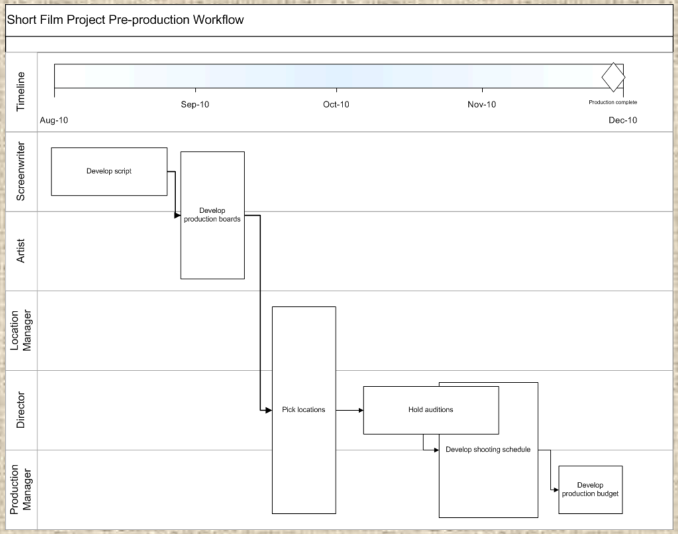
STAGE 2 – PREFEASIBILITY STUDY

- Assessment of the current regulatory environment, stability assessment and possible risk of future changes (for example, likelihood of changes during upcoming regional/national elections).
- Solutions to specific challenges; as challenges to the project arise, possible solutions will begin to be identified. For example, if the power off-taker does not have a strong credit rating, the developer may want to explore the possibility of a sovereign guarantee

STAGE 2 – PREFEASIBILITY STUDY

- Preliminary timeline for project activities; while the scheduled workflow will inevitably change significantly it is important to begin to understand the spacing and timing of key required activities at an early stage.



STAGE 2 – PREFEASIBILITY STUDY

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Prefeasibility Checklist

Below is a checklist of key considerations for the developer during the prefeasibility stage:

- ☐ Assessment of the site and boundary areas including access permissions and restrictions.
- ☐ Conceptual design completed including consideration of technology options and their financial impacts.
- ☐ Approximate costs for land, equipment, delivery, construction, and operation identified along with predicted revenue.
- ☐ Indicative energy yield completed.
- ☐ Identification of anticipated electricity tariff to be received, and review of expected terms/conditions of PPAs in the relevant market.
- ☐ High-level financial analysis completed.
- ☐ Cost and likelihood of achieving grid connection in the required timescales identified.
- ☐ Main environmental constraints identified along with other potential "deal breakers."
- ☐ Assessment of current and potential future regulatory environment completed.
- ☐ An initial concept of the project's legal/corporate structure.
- ☐ Solutions to project challenges.
- ☐ Permitting requirements/costs identified.
- ☐ Preliminary project timeline/workflow showing spacing of key activities drafted.

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Feasibility Study

Technical and financial evaluation of preferred option
Assessment of financing options
Initiation of permitting process
Development of rough technical concept

- First contact with project development

FEASIBILITY STUDY

The feasibility phase will build on the work undertaken at the prefeasibility stage by repeating the assessment in more detail using site-specific data, such as solar resource

measurements, and should consider any previously identified constraints in more detail.

If the results of the study are favorable, the developer should be prepared to invest more to advance the project to the financing stage.

typical scope for a feasibility study is outlined below in terms of key technical, regulatory, financial, and commercial aspects.

FEASIBILITY STUDY

- Tilt angle, orientation, and tracking.
- Temperature and wind profiles of the site.
- Cable runs and electrical loss minimisation.

•Production of a detailed site plan, including site surveys, topographic contours, depiction of access routes, and other civil works requirements

•Calculation of solar resource and environmental characteristics, especially those that will impact performance of technical requirements (temperature, wind speed, and geological hazards)

FEASIBILITY STUDY

- Electrical cabling design and single line diagrams
- Electrical connections and monitoring equipment.
- Grid connection design, including transformers and
- metering, etc.
- Full energy yield analysis using screened solar data and the optimised layout

FEASIBILITY STUDY

Assessment of all technology options and cost/benefit analysis of potential suppliers given the project

location, including:

Module selection. This is an optimized selection based on the feasibility phase output, and pricing in the market place. Note that in countries where the solar industry is still in

its infancy, there may be challenges when importing solar modules and other critical components of

plant infrastructure. Examples include delays at customs and difficult negotiations on the terms of sale with manufacturers lacking a local sales representative or distributor.

FEASIBILITY STUDY

- Inverter selection. Manufacturers are predominately based in Europe and North America, though others are emerging in China and Japan. As above, importation can result in delays to project schedules.
- Mounting frame or tracking system selection, including consideration of site specific conditions

FEASIBILITY STUDY

PERMITTING AND ENVIRONMENTAL, HEALTHAND SAFETY (EHS) REQUIREMENTS

- Detailed review and inventory of all necessary permits and licenses needed for constructing and operating the power plant. Examples are environmental permits, land use permits, and generator licenses

FEASIBILITY STUDY

FINANCIAL FEASIBILITY OF PROJECT

•modelling includes all costs and revenues. It should also involve a sensitivity analysis to start assessing the project risks

FEASIBILITY STUDY

PROJECT DEVELOPMENT/COMMERCIAL ASPECTS

Project implementation plan) including a Gantt chart laying out the project timeline,

resource requirements, project development budget, procurement concept (e.g., full turnkey or multicontracting approach), and O&M concept.

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FEASIBILITY STUDY

It should be noted that the feasibility study may overlap with activities related to permitting, financing, andcontracts (see next phase) that are being carried out in parallel. Coordination of all technical, commercial, and regulatory activities is essential for the success of the project.

FEASIBILITY STUDY

- Preparation of solar PV module tender documentation.

Supplier/contractor selection and contract negotiations.

- Preparation of construction of plant tender documentation.

- Preparation of PPA documentation and final negotiations.
- Preparation of O&M concept and contracts, as relevant.
- Preparation of Owner's Engineer tender (if technical advisor is not continued into construction).

FEASIBILITY STUDY

- Contracting and procurement of relevant insurances (i.e., construction, operation, etc.).
- Finalization of grid interconnection agreement with grid operator or relevant authority.

- Preparation of detailed, bankable financial

FEASIBILITY STUDY

Completion of a project risk analysis.

Transportation analysis as necessary for difficult-to reach project locations.

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PERMITTING, CONTRACTS AND FINANCING

- After the feasibility stage and assuming that the project still seems to be financially viable, the project moves to the next stage. This includes obtaining final permits, securing project finance and pre-implementation activities commercial contracts). The timing and sequencing of (this stage will vary significantly by project, but this phase usually includes the following activities:

NextStage

FINANCING/CONTRACTS

Permitting
Contracting strategy
Supplier selection and contract negotiation
Financing of project
Due Diligence Financing concept

PERMITTING

- ❑Land lease agreement(s).
- ❑ Access agreements.
- ❑ Planning/land use consents.
- ❑ Building/construction permits.
- ❑ Environmental permits
- ❑Social impacts (i.e., cultural heritage/archaeological
- ❑sites, stakeholder consultations).
- ❑ Energy permit.
- ❑ Grid connection application.
- ❑ Operator/generation licenses

Financing

- Financing a solar PV project is similar in principle to financing other types of power projects, however, certain risks that are unique to solar PV must be accounted for in the financing plan. Risks associated specifically with solar PV projects are related to the energy resource (irradiation), project siting and permitting, solar technology (relatively new), potential degradation of PV modules, and reliability of long-term plant performance, as well as potential uncertainty of the tariff and revenue collection.
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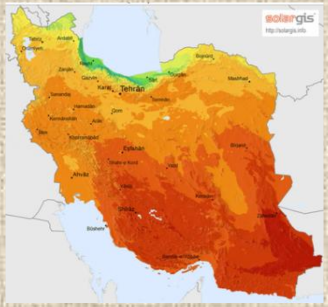

Contracts

•Contracts present developers with several important considerations. Perhaps foremost is establishing a project company or SPV (special purpose vehicle); if not already initiated, an SPV should be formally established. The developer typically creates and owns the project company, potentially with equity co-investment from another financial backer (sponsor),

event of default).

DETAILED DESIGN

Preparation of detailed design for all relevant lots
Preparation of project implementation schedule
Finalization of permitting process

- Loan agreement

Development of Detailed PV Design

A single EPC contract is most commonly used for developing PV plants. In this case, one contractor is responsible for the complete project. The EPC contractor is required to confirm the solar energy resource, develop the detailed design of the PV plant, estimate its energy yield, procure the equipment according to specifications agreed upon with the developer, construct the PV plant carry out the acceptance tests, and transfer the plant for commercial operation to its owner/operator.

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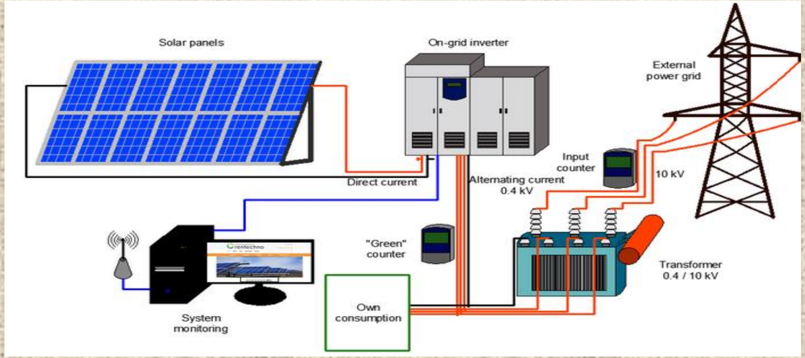
ENGINEERING, PROCUREMENT, CONSTRUCTION AND COMMERCIAL OPERATION

The EPC contractor will prepare the necessary detail documentation for the solar PV plant to be tendered and constructed. The following documentation will be prepared:

- Detailed layout design.
- Detailed civil design (buildings, foundations, drainage, access roads).
- Detailed electrical design.
- Revised energy yield.
- Construction plans.
- Project schedule..
- Commissioning plans.

Electrical System

Overall single line diagrams.
• Medium voltage (MV) and low voltage (LV) switchgear line diagrams.
• Protection systems.
• Interconnection systems and design.
• Auxiliary power requirements.
• Control systems.



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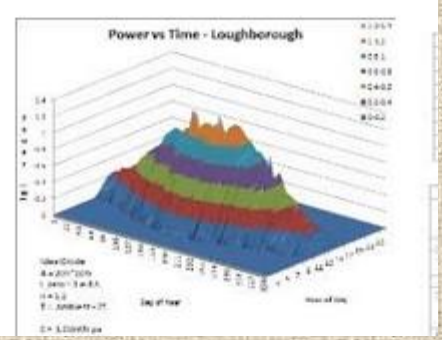
energy yield

- Consideration of site-specific factors, including soiling or snow, and the cleaning regime specified in the O&M contract.
- Full shading review of the PV generator including near and far shading.
- Detailed losses and performance degradation over time.



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Detailed Project Documentation

The information that should be included
are detailed below:

- Site layout showing the location of modules, inverters, and buildings.
- Mounting frame and module layout.
- Inverter locations and foundations/housings.
- Security measures.
- Initial electrical layouts:

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Detailed Project Documentation

- Schematics of module connections through to the inverter.
- Single line diagrams showing anticipated cable routes.
- Grid connection and potential substation requirements.
- Bill of materials for major equipment.
- Energy yield analysis.
- Losses assumed

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Detailed Project Documentation

• Copies of all contracts negotiated:
• PPA.
• EPC Contract.
• Equity subscription agreement and incorporation documents for project SPV.
• Copies of applicable insurance and other risk mitigation.
• Details of the permitting and planning status.
• Environmental impact, restrictions, and mitigation plans.

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CONSTRUCTION

Construction supervision

CONSTRUCTION AND COMMERCIAL OPERATION

•After the contract(s) have been awarded (whether multiplier a single EPC), the role of the developer is to oversee the implementation of the project. This can be done

•using the developer's own staff, if they have the expertise and experience, or by hiring an Owner's Engineer. Each contractor designs, procures, and installs the components of the PV plant under the terms of its contract. If multiple contracts are awarded, coordination of schedule and interfaces is critical.

COMMISSIONING

Performance testing
Preparation of as build design (if required)

• Independent review of commissioning

License Issuance

License Issuance

Nongovernmental applicants who wish to construct renewable energy power plants should fill the required worksheets that are downloadable from SUNA website and present to non-governmental partnerships office of SUNA attached to a written application, company documentation's such as statute, registration ad in official gazette and its latest amendments and coordinates of the project site so that construction permit is issued for a certain capacity in maximum one week.

Ministry of Energy
Renewable Energy and Energy Efficiency Organization (SATBA)

Ministry of Energy
Islamic Republic of Iran

Date:
No.:
Annex:

License to Establish Renewable and Clean Power Plant

This license is issued

Relying on articles 5 and 6 of Iranian organizational law for electricity and authorization entrusting No. 94/16346/350 dated May 24,2015 by the Energy vice minister for electricity and energy in connection with the nongovernmental renewable power plants development policy as per request No. ………… dated ……………… by …………… Company Reg. No. ………………. national ID card No. ………… in …………… to establish a …………… power plant in …………… province complying with the following conditions and obligatory provisions signed by authorized signatories attached to the above mentioned request:

[1]. This license is valid for six months from the date of issue, and it is non-extendable, unless the licensee submits two of the three licenses (environmental, grid connection, or land-lease permits). In this case the license can be extended for a maximum of a six month period.
[2]. The license is non-transferable to others, and it will be null and void if any transfer under any manner to be taken.
[3]. Licensee is responsible for feasibility study, potential assessment, and evaluation of the energy sources, design, selection and equipment supply, budgeting, construction and operation of the power plant, production, transmission, sales of electricity, grid connection and technical protection. The license issuing authority is not responsible for all the cases mentioned.
[4]. Development, change in power plant location, increase in power plant capacity, rename, duplicate issuance, and extension of the period will depend on the licensee's request and decision by Ministry of Energy-Renewable Energy and Energy Efficiency Organization (SATBA).
[5]. Licensees are ultimately responsible for obtaining any necessary permits such as environment, grid connection and land delivery and the related possible change of land use and its expenses in case of all the renewable power plants. The licensee is also expected to obtain waste permit for waste-based biomass power plants as well as river use and water transfer lines for small hydro power plants from relevant authorities. This license is merely for the establishment of power plants and a separate letter of introduction will not be issued to be presented to relevant authorities unless for governmental land supply which should be requested by the applicant.
[6]. Exchange and export of electricity produced abroad depends on receiving a separate permit from the license issuing authority. If such a mentioned permit is not received, this license will be null and void.
[7]. Nonautomic and nonstick exchange transfer of more than 25% of the licensee's share is allowable after the operation of the power plant with the mentioned capacity in this license and depends on a written and approval of the license issuing authority in advance, otherwise the license would be invalid.
[8]. Upon expiration of license validity, it will be automatically null and void with no special action. If any extension is required, one month prior to expiration, relevant request for extension should be submitted. After the license is expired, no claim for any incurred cost by the applicant will be accepted.
[9]. To facilitate the license issuance, no financial qualification or legal competence of the applicant would be assessed. Licenses will not have thus any financial credit in this regard and the licenses cannot be used as collateral and guarantee.
[10]. Issuance of this license causes no restrictions for the issuing authority to issue similar licenses.
[11]. Applicant's commitment letter for the construction of power plant is an integral part of this license.
[12]. The equipment and technology of the power plant and relevant know-how have been chosen by the applicant who is responsible for any technical performance safety, right of intellectual ownership, right of economic utilization and return and replying to any probable claims. SATBA will not be responsible for all the mentioned and similar cases.
[13]. In case of whole or part of the power plant's capital cost that is financed by foreign investment, obtaining the license from Organization for the Investment, Economic and Technical Assistance of Iran (OIETA) is essential.
[14]. Non-agriculture uses of land for construction of power plants is the policy of SATBA. In case of using the lands with agriculture application, the law for preservation of the agriculture lands and gardens are necessary and the organization is not responsible in this regard.

Grid Connection permit

In order to obtain the grid connection permit, you may refer to Distribution Electricity Company or Regional Electricity Company related to the site location of your power plant by submitting a valid construction permit and introduction letter from Renewable Energy Organization of Iran.

Environmental permit

In order to obtain the environmental permit, you may refer to Environmental Protection Office related to the site location of your power plant by submitting a valid construction permit and introduction letter from Renewable Energy Organization of Iran.

Environment Agency

Mohammad Parhamfar

Land Use permit

In order to obtain the land use permit, in case of obtaining the land lease from natural sources, you may refer to land affairs organization related to the site location of your power plant by submitting a valid construction permit and introduction letter from Renewable Energy Organization of Iran and related documents of the land.

Purchase Contract

After obtaining environmental, grid connection and land use permits (if needed) the long-term purchase contract will be concluded with the applicant in that case the applicant can start the executive operations of construction period of the power plant.

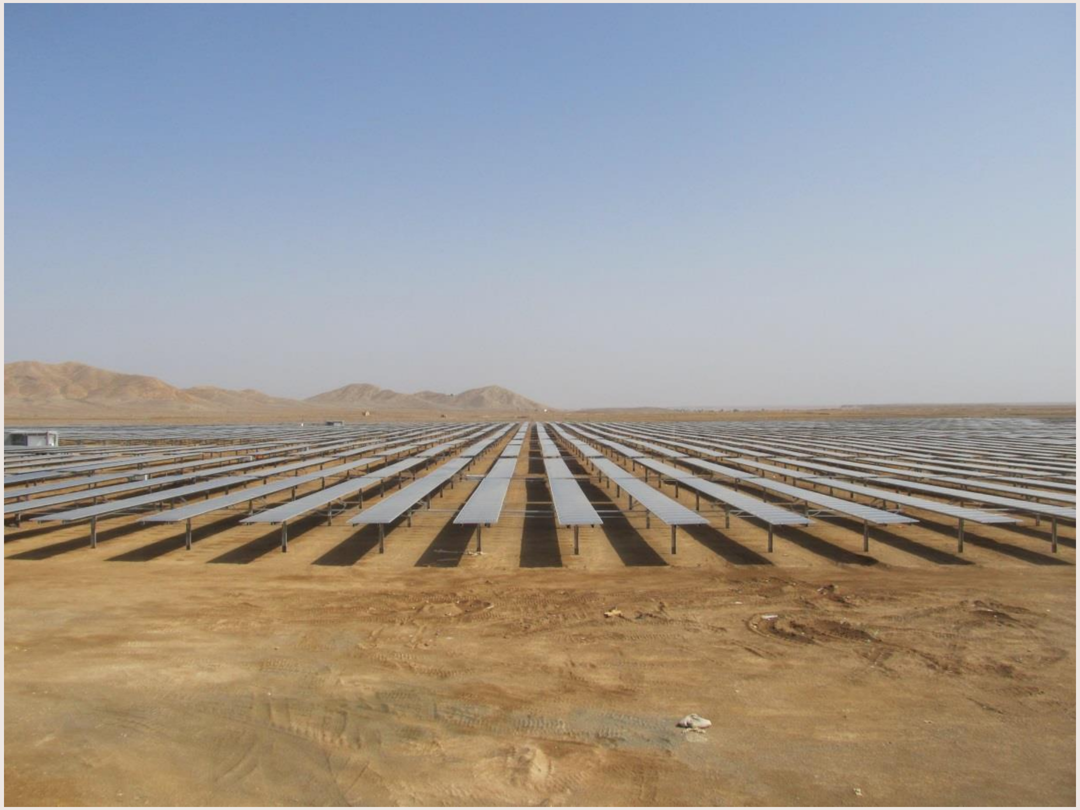
Validation for The PPA

The rates of this announcement are valid for the PPAs which the power plants will be constructed and commercially operated within a maximum of30 months for biomass ,geothermal and small hydro power plants ,also a maximum of24 months for wind , waste heat recovery (WHR) power plants in industrial processes and a maximum of 15 months for different types of solar power plants since the signing date of the PPA. In case of delay, the tariff which is in current for new contracts or the tariff mentioned in the contract, which ever is lower, will be applied on the start date of commercial operation.

operation

After the construction and operation of the power plant, the guaranteed purchase of electricity will be applied under the terms of the contract and all payments will be done based on the proposed bills in Rials monthly.

Metka Egn Project



UTM and Land coordination

Site environment specification

Minimum temperature: -5 Centigrade	**Average annual ambient temperature:** 16.3 Centigrade
Elevation from sea level 1590 Meters	**Maximum temperature:** 39 Centigrade
Maximum wind speed: 6.69 m/s	**Average annual moisture:** 39.9%
Average annual raining: 0.77 mm	**Average wind speed:** 6.05 m/s

Energy Production

Energy Output MWh/year	Operation Year	Operation Year (Solar calender)	YEAR
0	2018	1396	1
21.953,16	2019.Mar.21/2020.Mar.20	1397	2
21.799,94	2020.Mar.21	1398	3
21.647,34	2021.Mar.21	1399	4
21.495,81	2022.Mar.21	1400	5
21.345,33	2023.Mar.21	1401	6
21.195,92	2024.Mar.21	1402	7
21.047,55	2025.Mar.21	1403	8
20.900,21	2026.Mar.21	1404	9
20.753,91	2027.Mar.21	1405	10
20.608,63	2028.Mar.21	1406	11
20.464,37	2029.Mar.21	1407	12
20.321,12	2030.Mar.21	1408	13
20.178,87	2031.Mar.21	1409	14
20.037,62	2032.Mar.21	1410	15
19.897,36	2033.Mar.21	1411	16
19.758,08	2034.Mar.35	1412	17
19.619,77	2035.Mar.21	1413	18
19.482,43	2036.Mar.21	1414	19
19.346,06	2037.Mar.21	1415	20

10 MW Solar plant

IRR	%	22.08
investment capital payback period	Year	5.1
equity capital payback period	Year	4.9

Project Data

- Project Name: Isfahan 10MW PV Plant
- Capacity (DC): 10.094,240kW$_p$
- Location: Jargouyeh, Isfahan
- Area: 200.000 m^2
- PPA: 20 years
- Construction: started October 2016
- Connection: targeted for February 2017

Mechanical structure

String Inverters:

- Easier to install
- Easier to replace
- More losses due to more DC to AC conversion points
- More points of potential faults
- O&M by simply replacing an inverter

Central Inverters:

- Need crane to install
- Better losses by using four centralized points for energy conversion
- Less points of potential faults
- O&M via preventive maintenance and good stock of spare parts

Central inverters chosen.

10 MW PV Solar

- Central inverters
- Ring configuration for Medium Voltage
- Central MV station for connection to Grid at 20kV
- Dual connection to grid
  - Undertaken by Iranian company

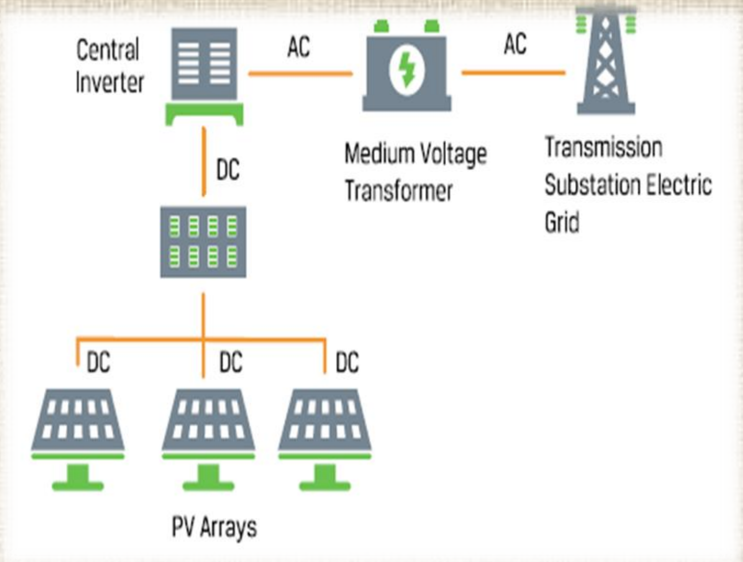
Inverters

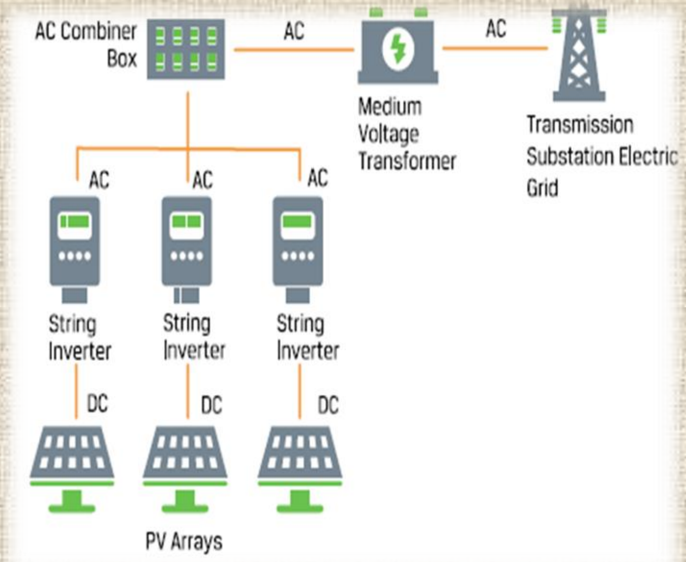
- Central Inverters design
- Using SMA SC2000 CP XT incorporated inside Medium Voltage Power Station
- Why choose central inverters?
  - Sup Inverters
  - Less losses via centralized conversion points
- Why choose SMA?
  - Reliability
  - Installation simplicity
  - Warranty

Central or String

Attribute	Central Inverter	String Inverter
Capacity	Up to 4 MW-AC	25 to 125 kW-AC
Installation	Concrete pad or steel skid, crane lift	Rack mountable, 2 person lift
Design	Isolation Transformer, typically grounded, air or liquid cooled	Transformer-less, typically floating ground, air or convection cooled
Cable losses	Shorter AC cable runs	Shorter DC cable runs
Grid Interaction	Advanced Inverter Functions (e.g. frequency/voltage control, reactive power compensation, etc.)	
Unplanned Maintenance	Service failed component in the field	Remove failed component, send to factory for possible refurbishment
Design Life	10 to 25 yr with refurbishment	+20 yr, limited (or no) field service
Maximum Power Point Tracker (MPPT)	Single or Multiple	Multiple
Warranty	~5-10 year	~10 year

Inverters


Central Inverter
AC
AC
DC
Medium Voltage Transformer
Transmission Substation Electric Grid
DC
DC
DC
PV Arrays

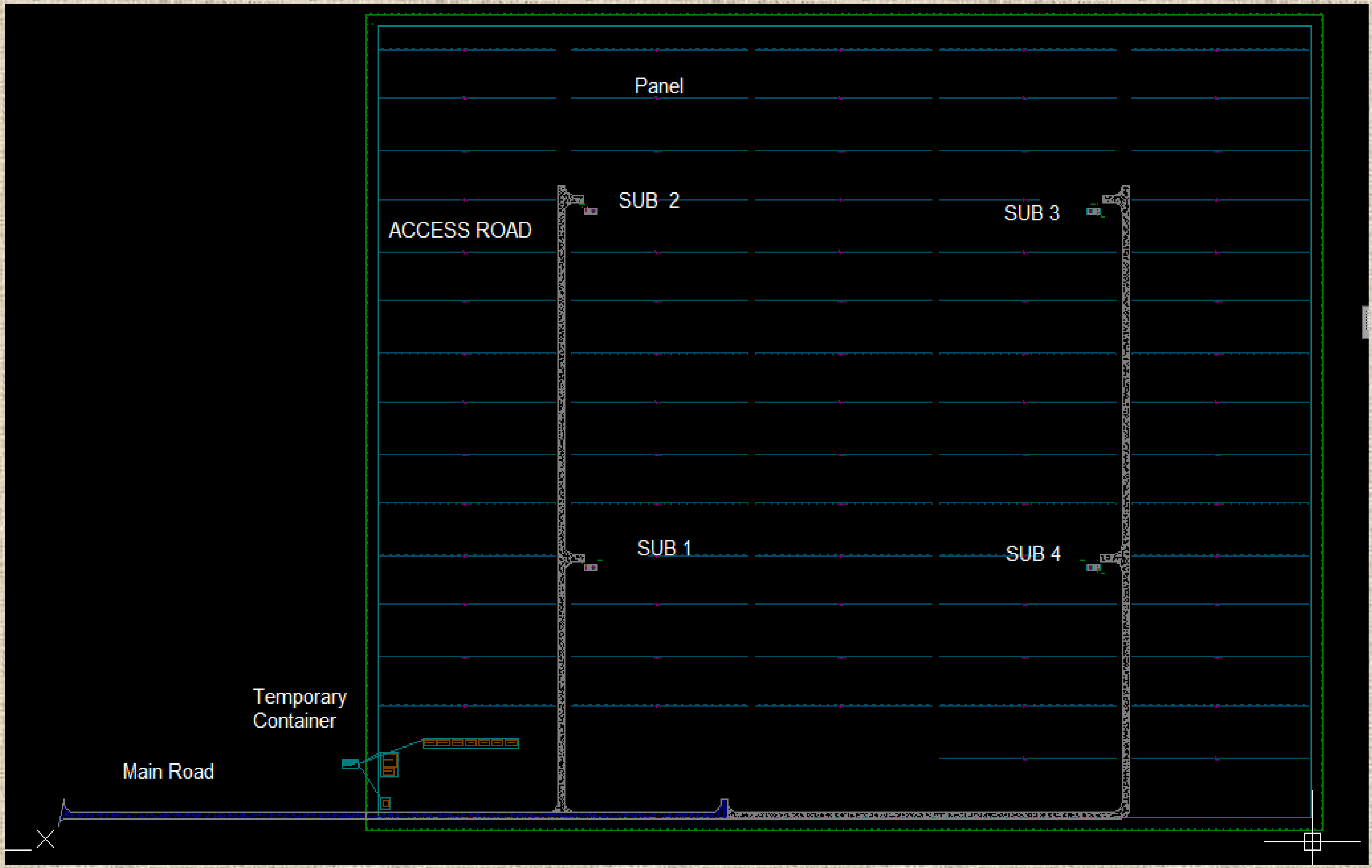

AC Combiner Box
AC
AC
Medium Voltage Transformer
Transmission Substation Electric Grid
AC
AC
AC
String Inverter
String Inverter
String Inverter
DC
DC
DC
PV Arrays

Inverter

Over the least few years ,the gap between the component level average selling price (ASP)of central and string inverters has closed dramatically.

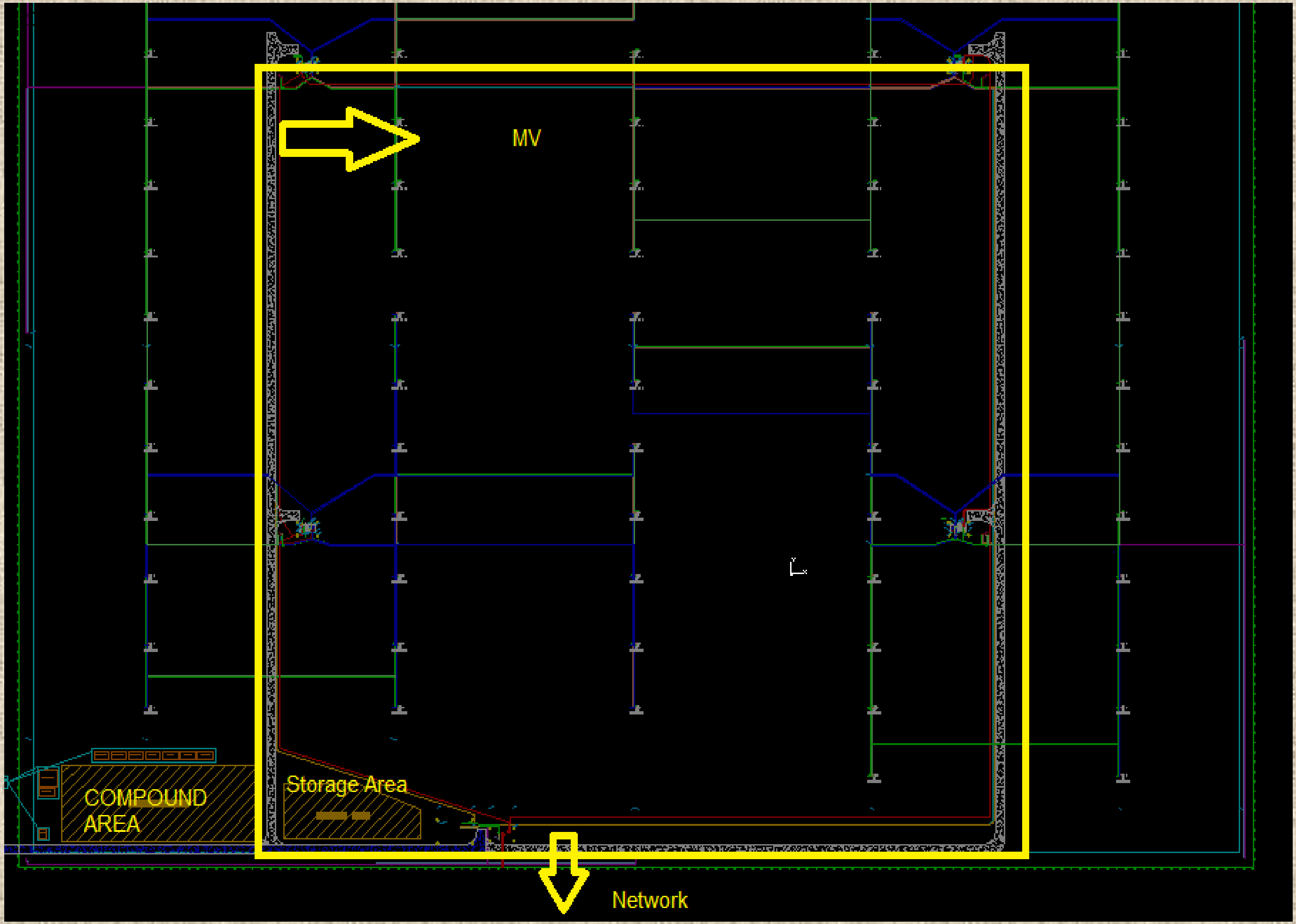
In fact ,it is expected that cost of string inverters will be only slightly higher than central inverters by 2020

Layout

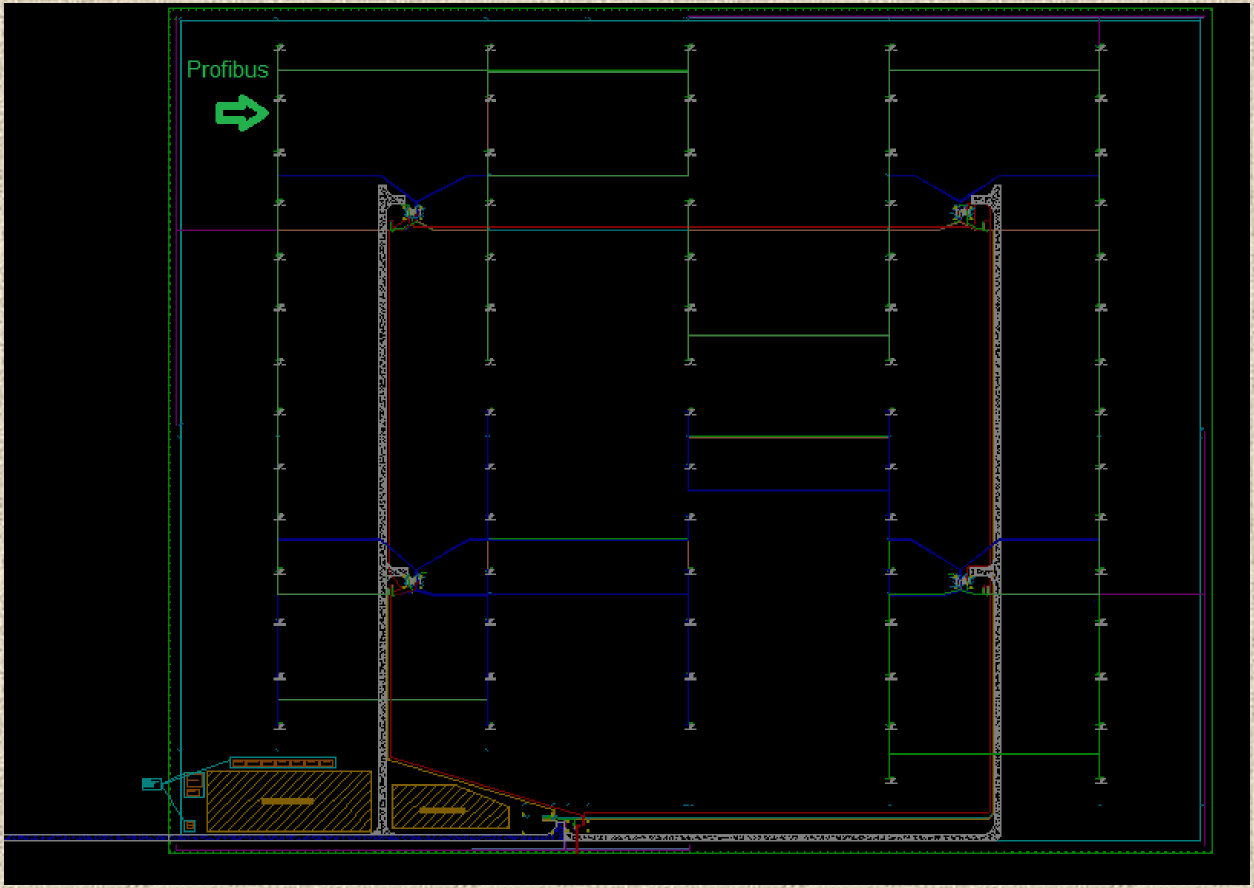


Panel
SUB 2
SUB 3
ACCESS ROAD
SUB 1
SUB 4
Temporary
Container
Main Road

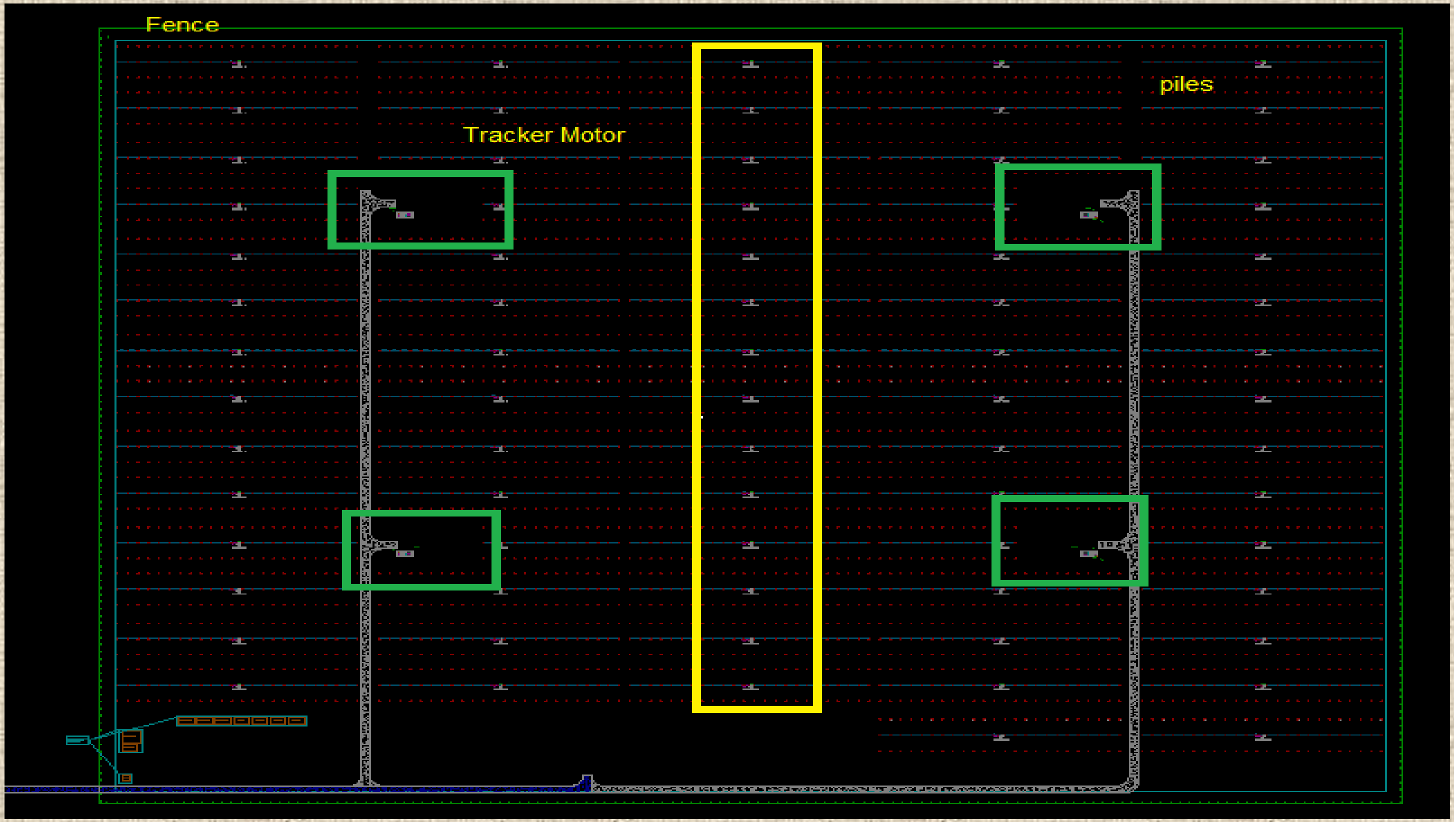
Layout-MV Ring



Layout



Fence-Tracker Motor-Piles



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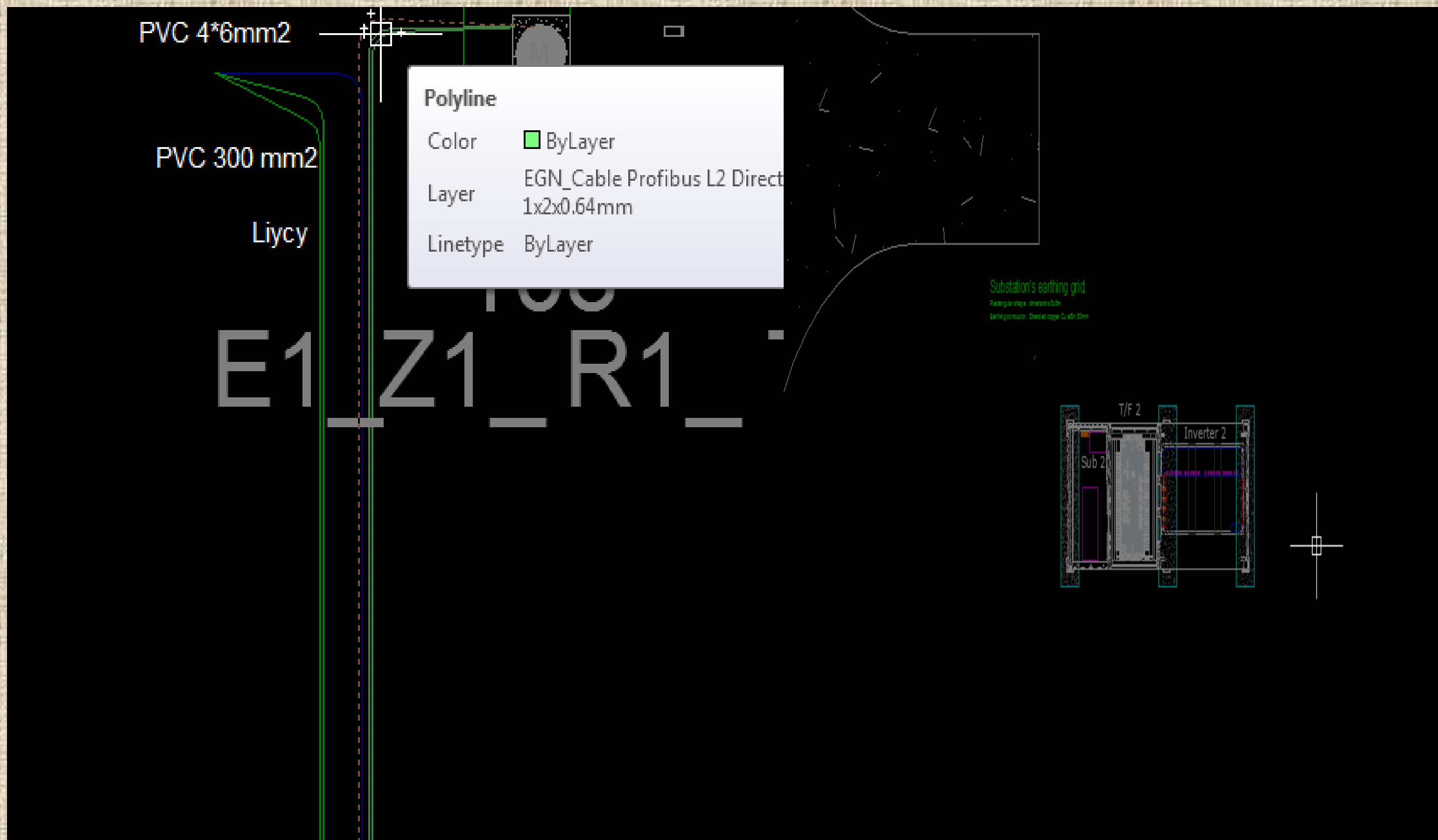
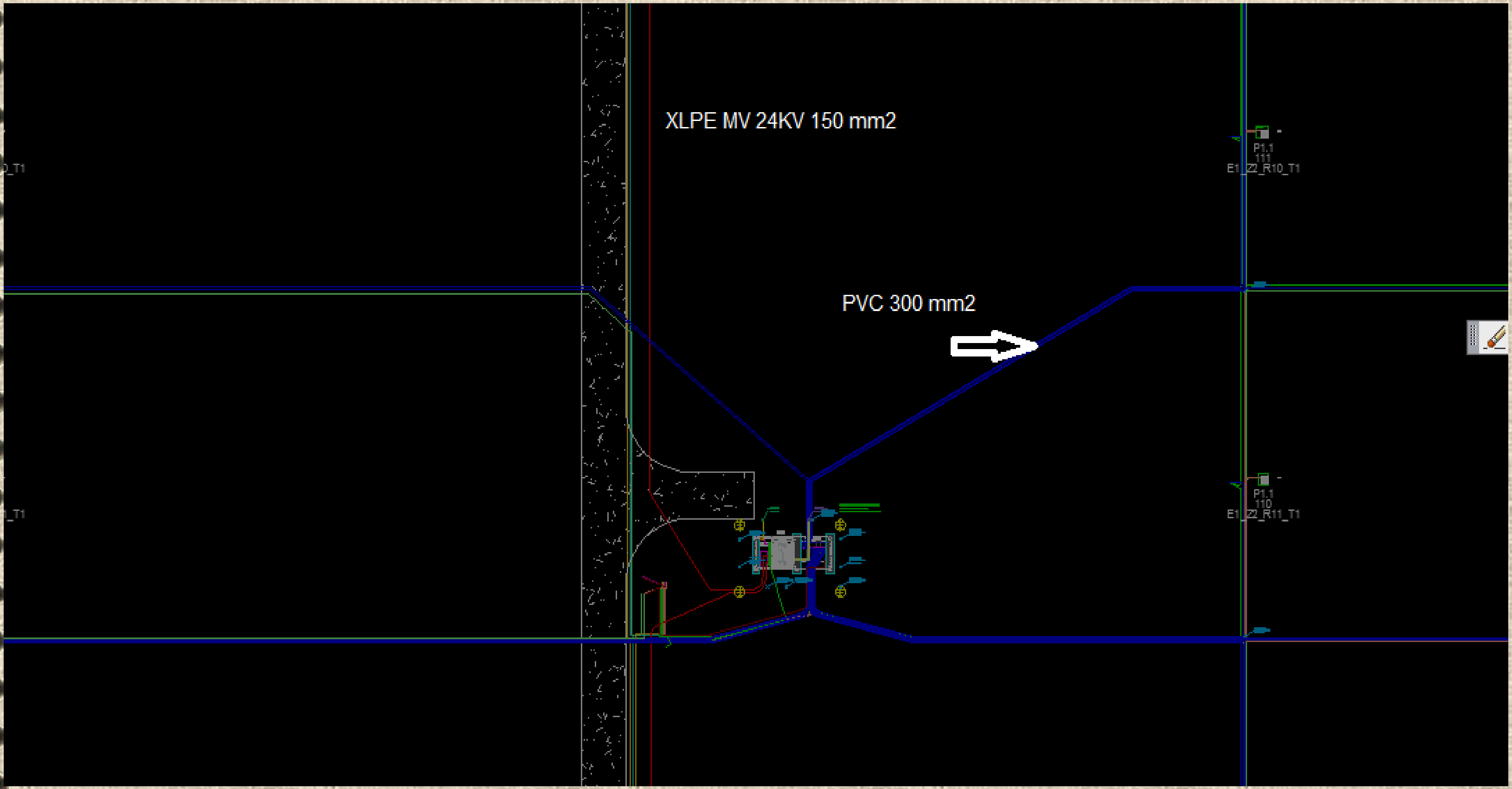
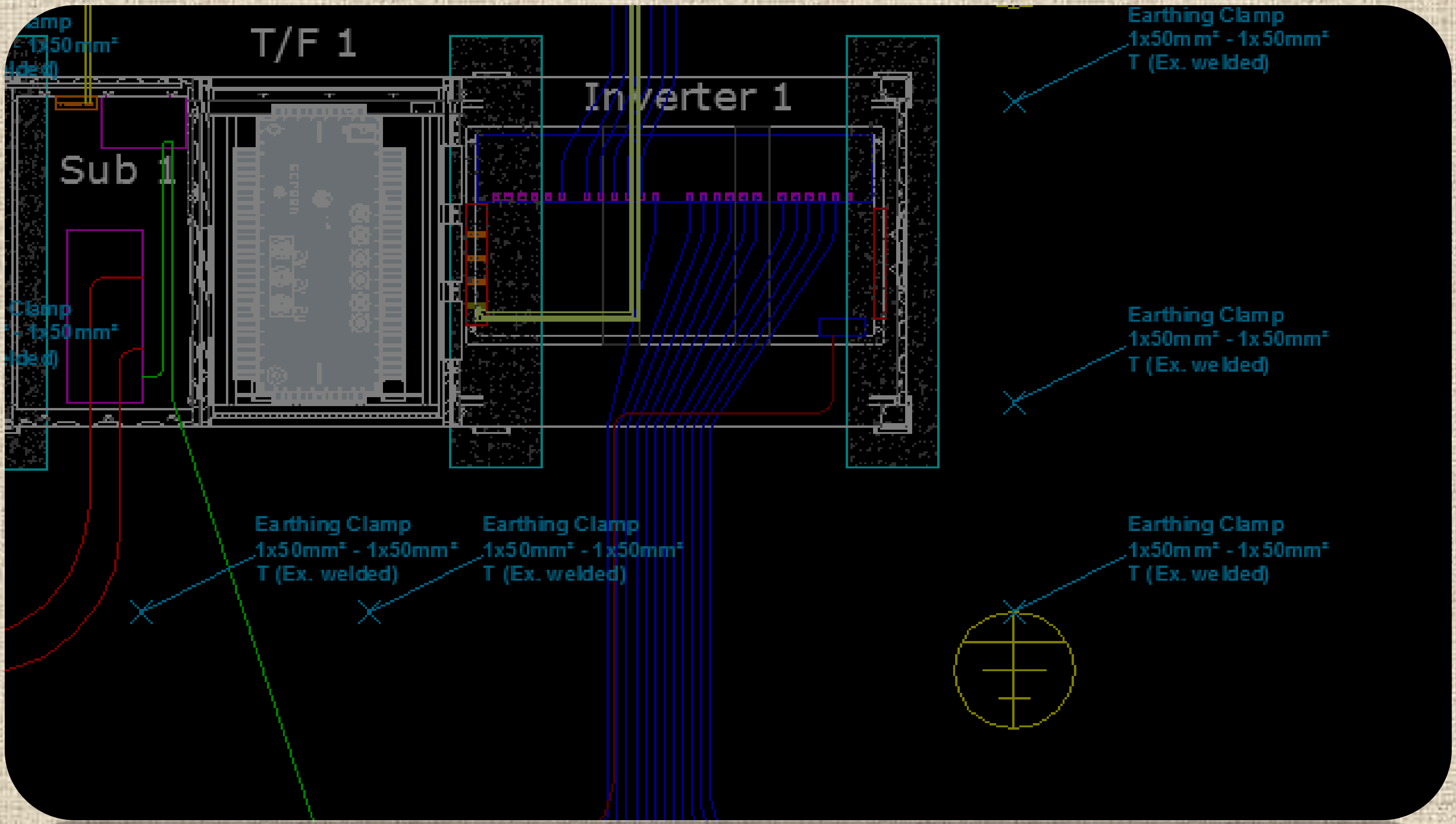
Inverter-Cabling



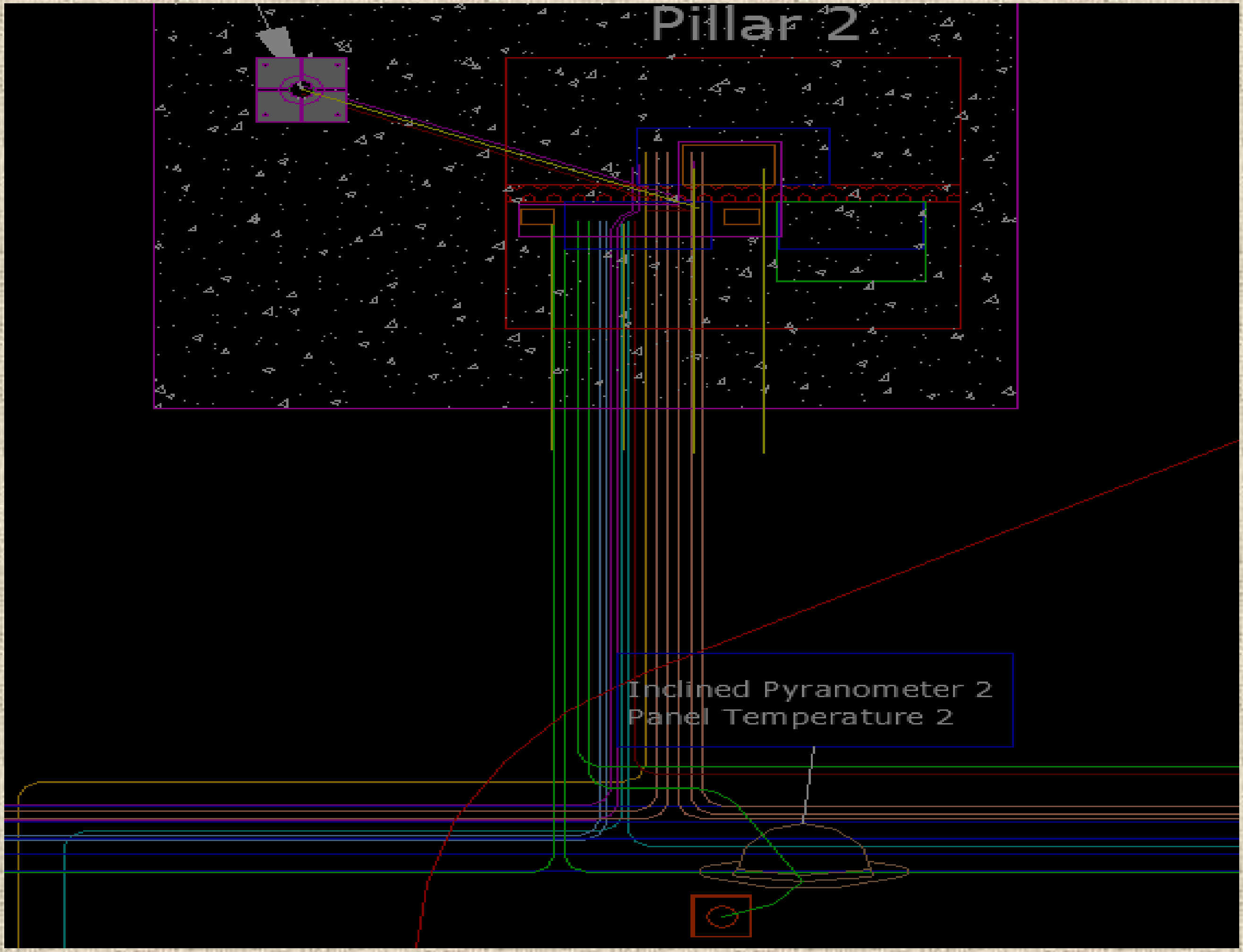
Dc Cable-Mv Cable



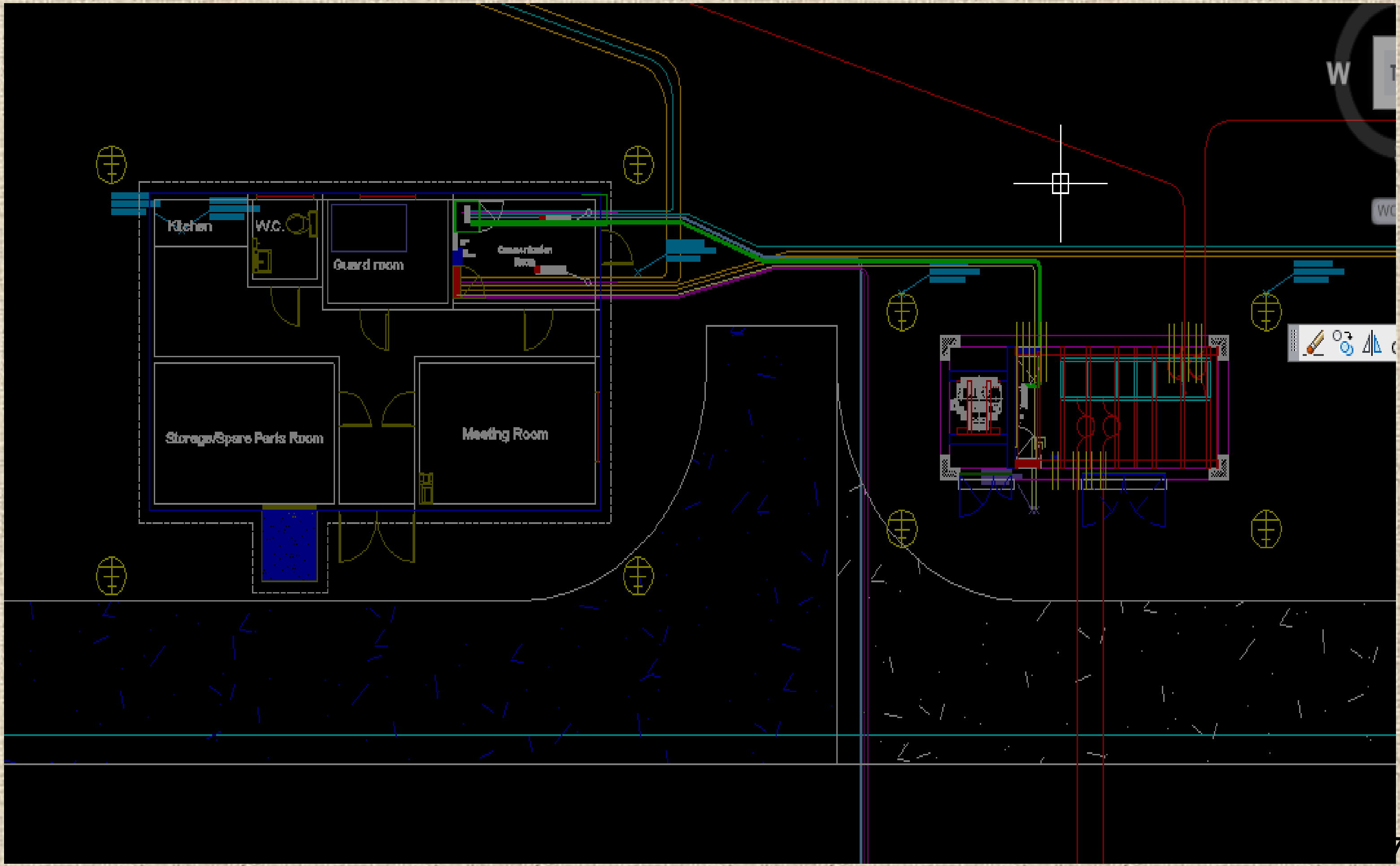
Inverters Details



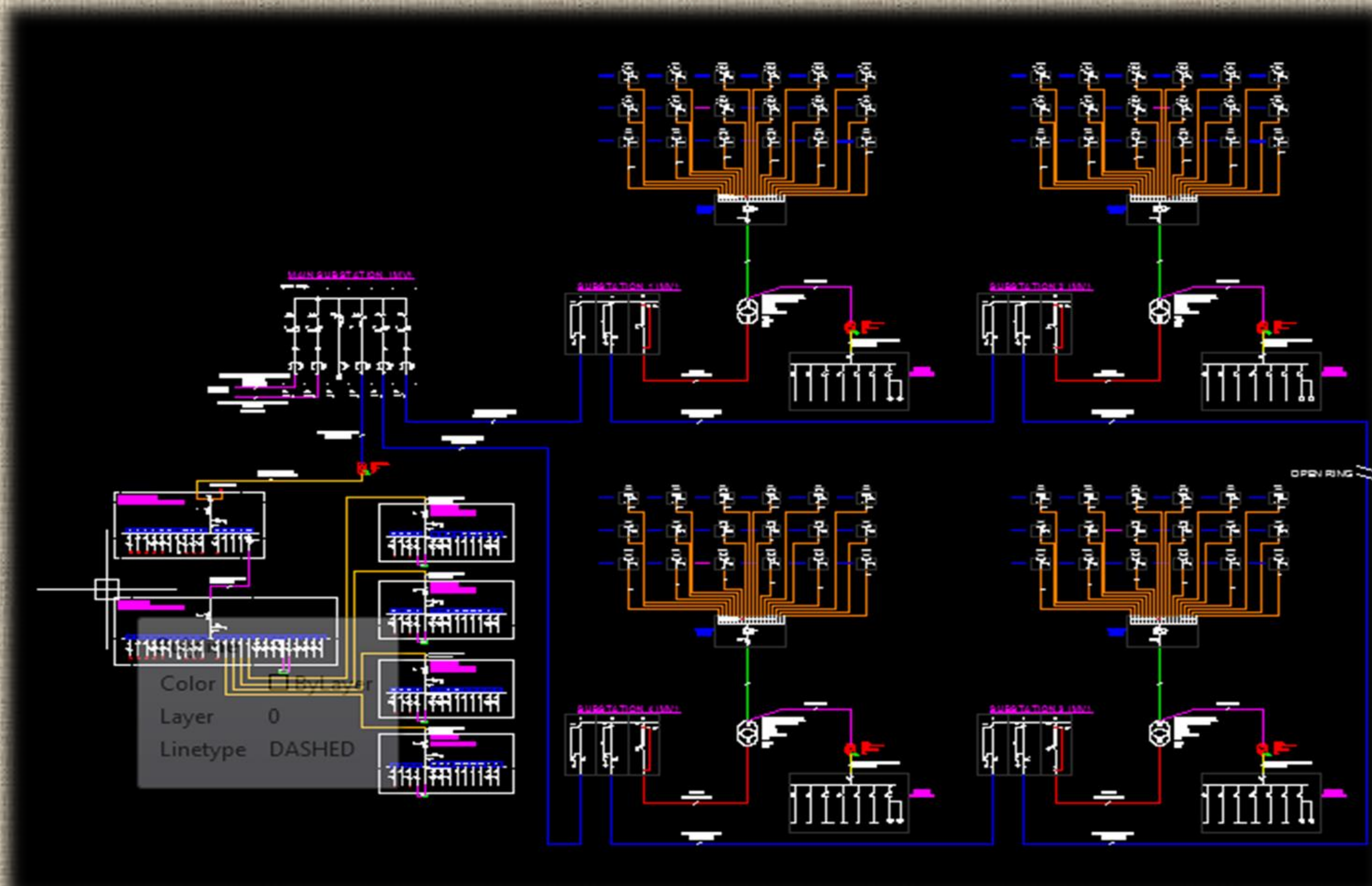
Pillar



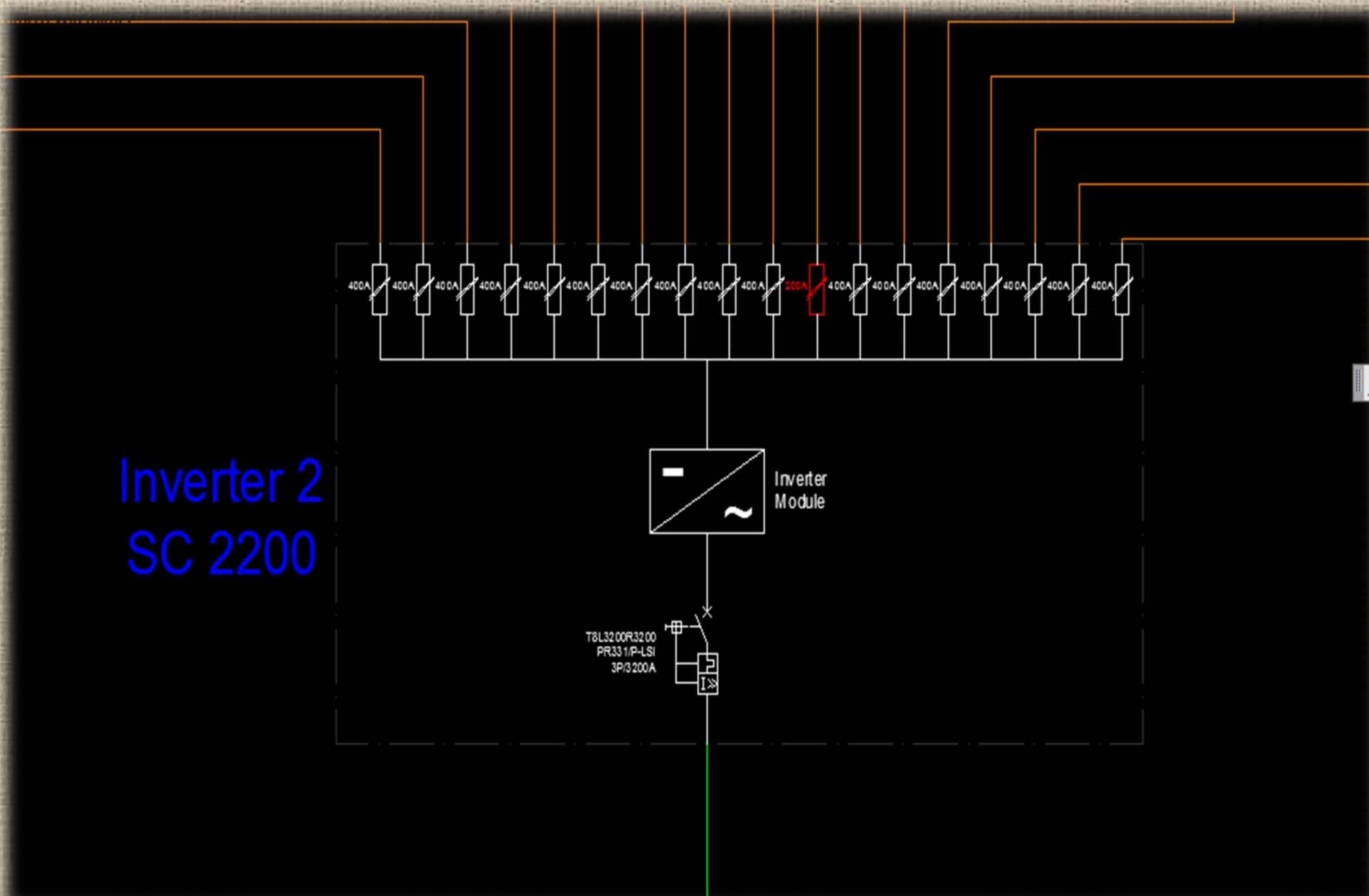
OM Building-Main transformer



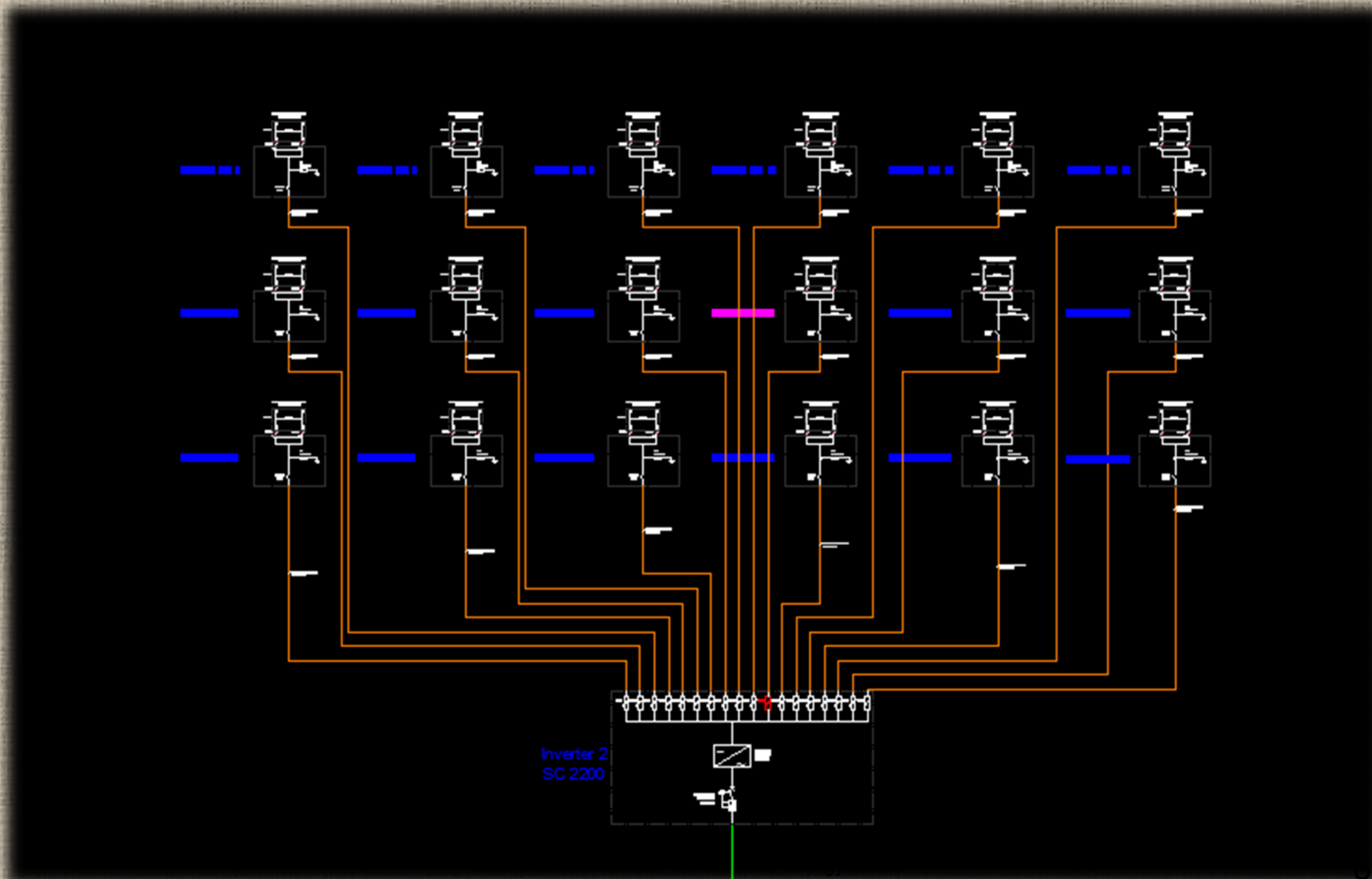
SLD



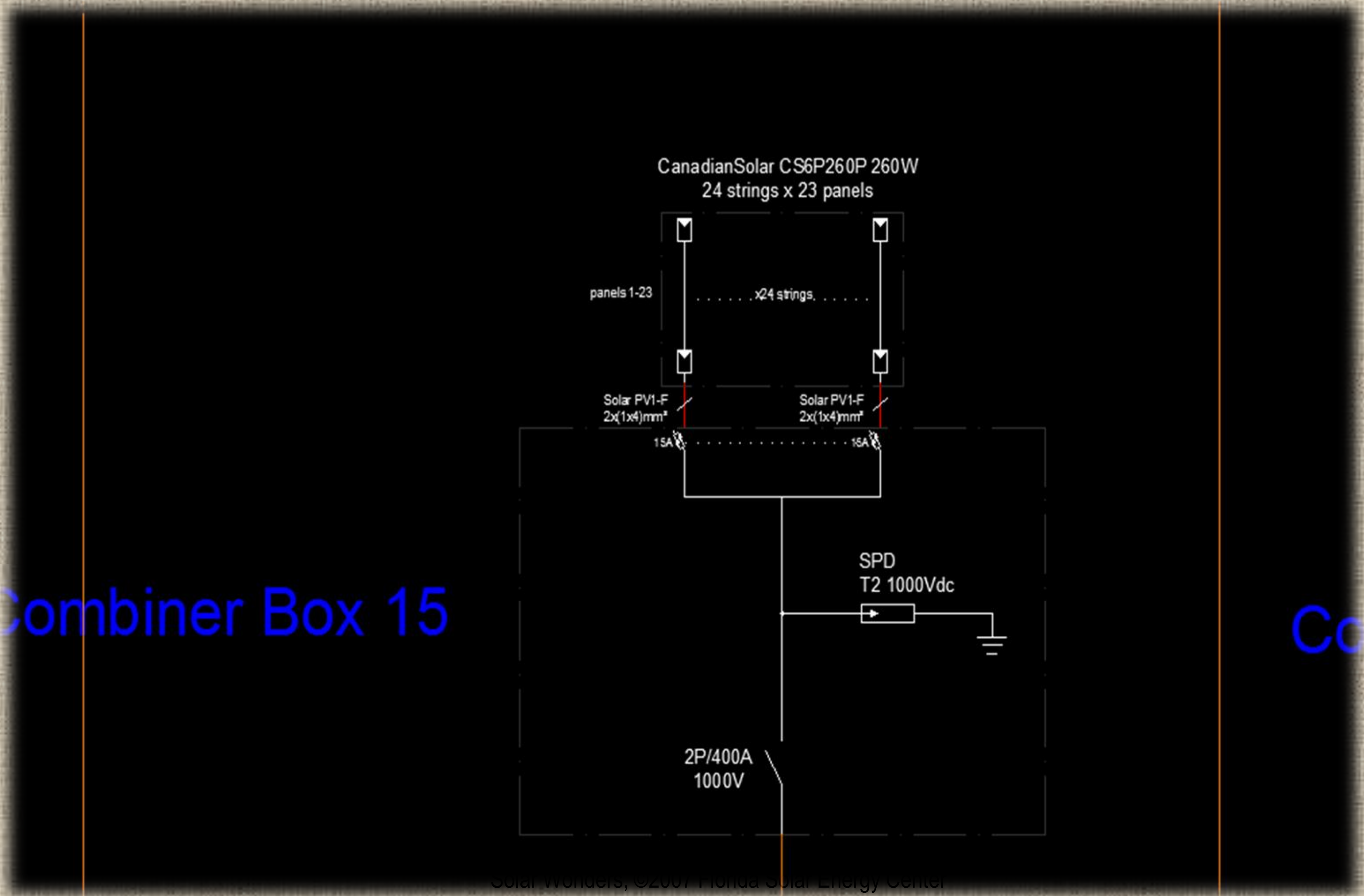
SLD-INVERTER



SLD

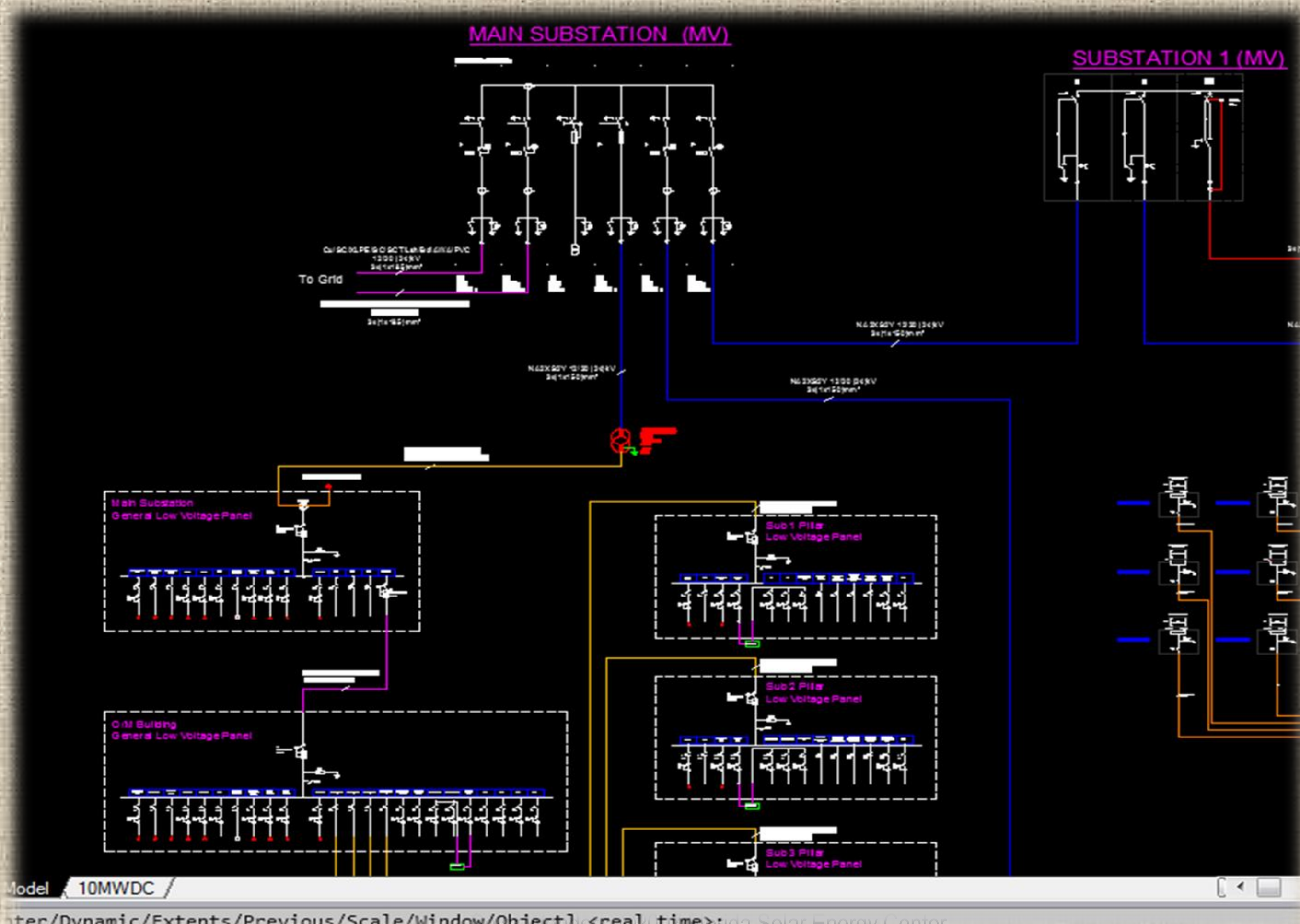


SLD

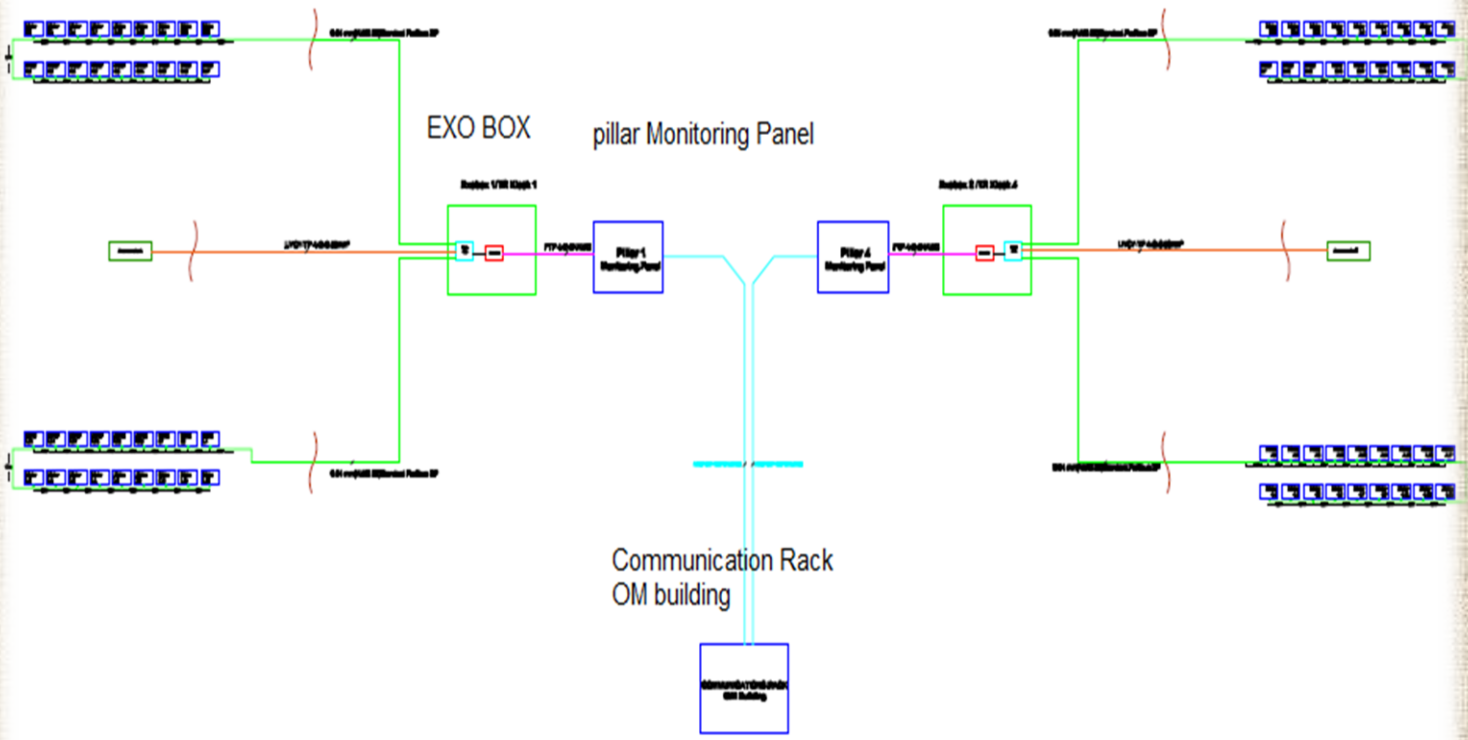


CanadianSolar CS6P260P 260W
24 strings x 23 panels
panels 1-23
x24 strings
Solar PV1-F
2x(1x4)mm²
Solar PV1-F
2x(1x4)mm²
15A
15A
SPD
T2 1000Vdc
2P/400A
1000V
Combiner Box 15

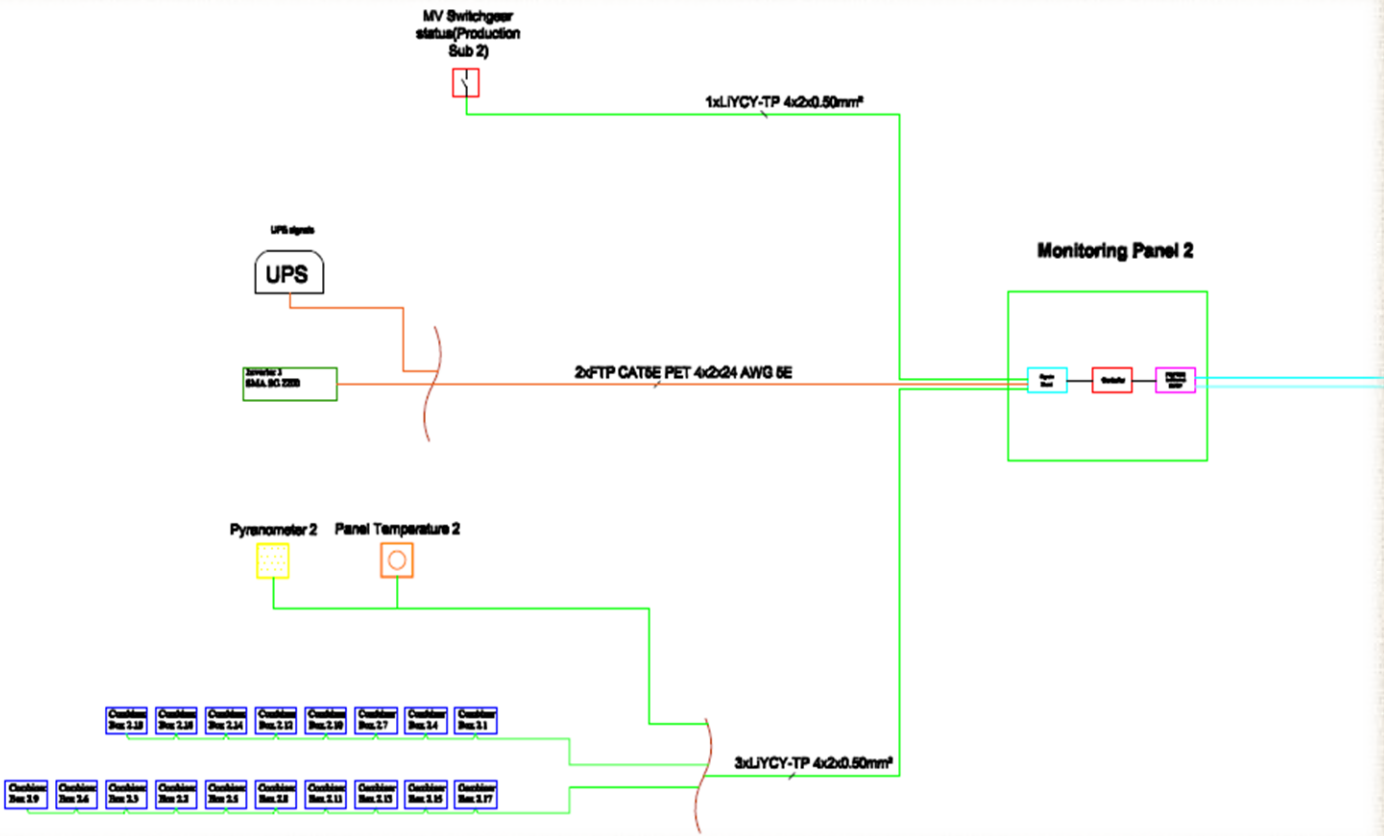
SLD


MAIN SUBSTATION (MV)
SUBSTATION 1 (MV)
To Grid
Main Substation
General Low Voltage Panel
O&M Building
General Low Voltage Panel
Sub 1 Pillar
Low Voltage Panel
Sub 2 Pillar
Low Voltage Panel
Sub 3 Pillar
Low Voltage Panel
Model
10MWDC
nter/Dynamic/Extents/Previous/Scale/Window/Object] <real time>:

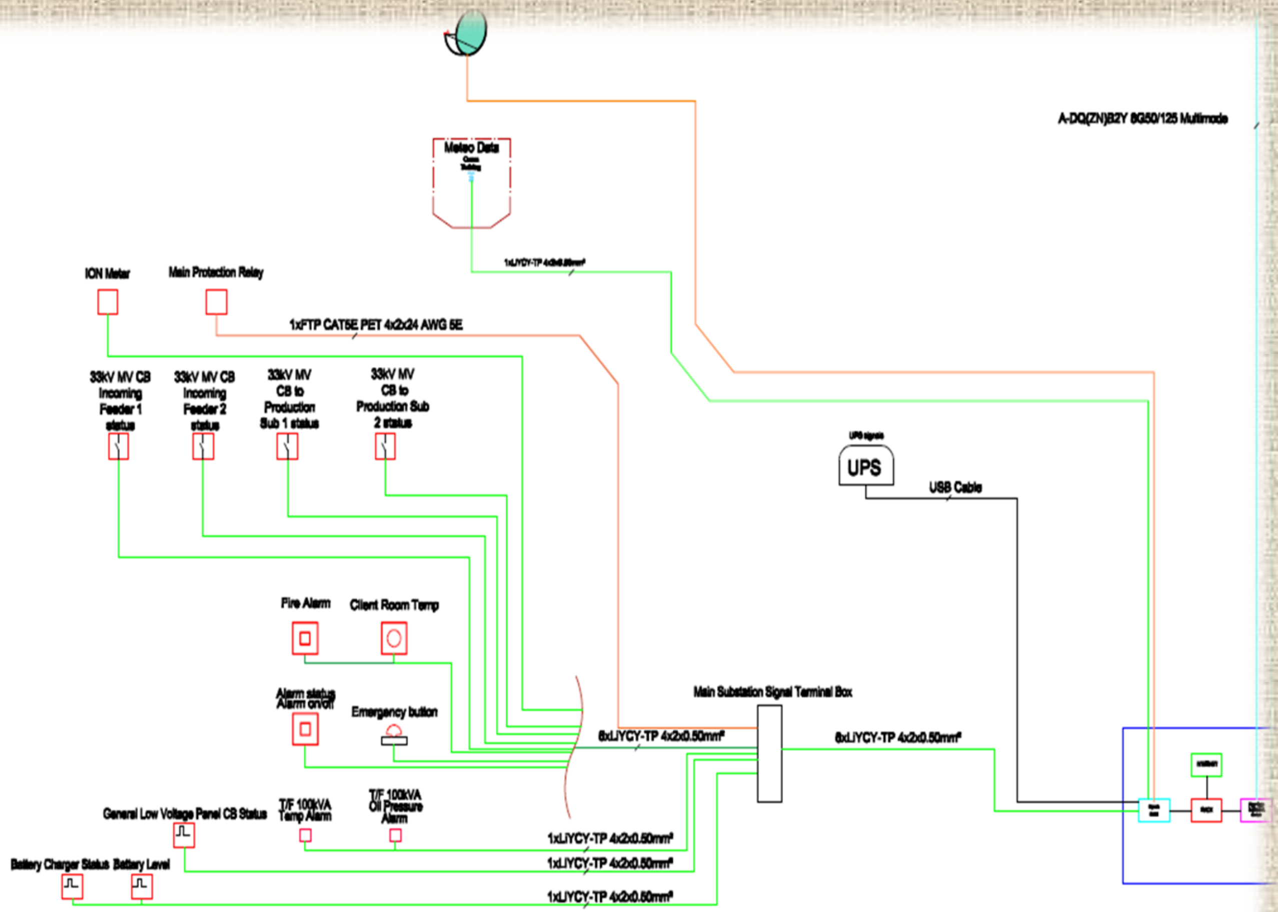
Communication



Communication



Communication



متخصصین برق ایران

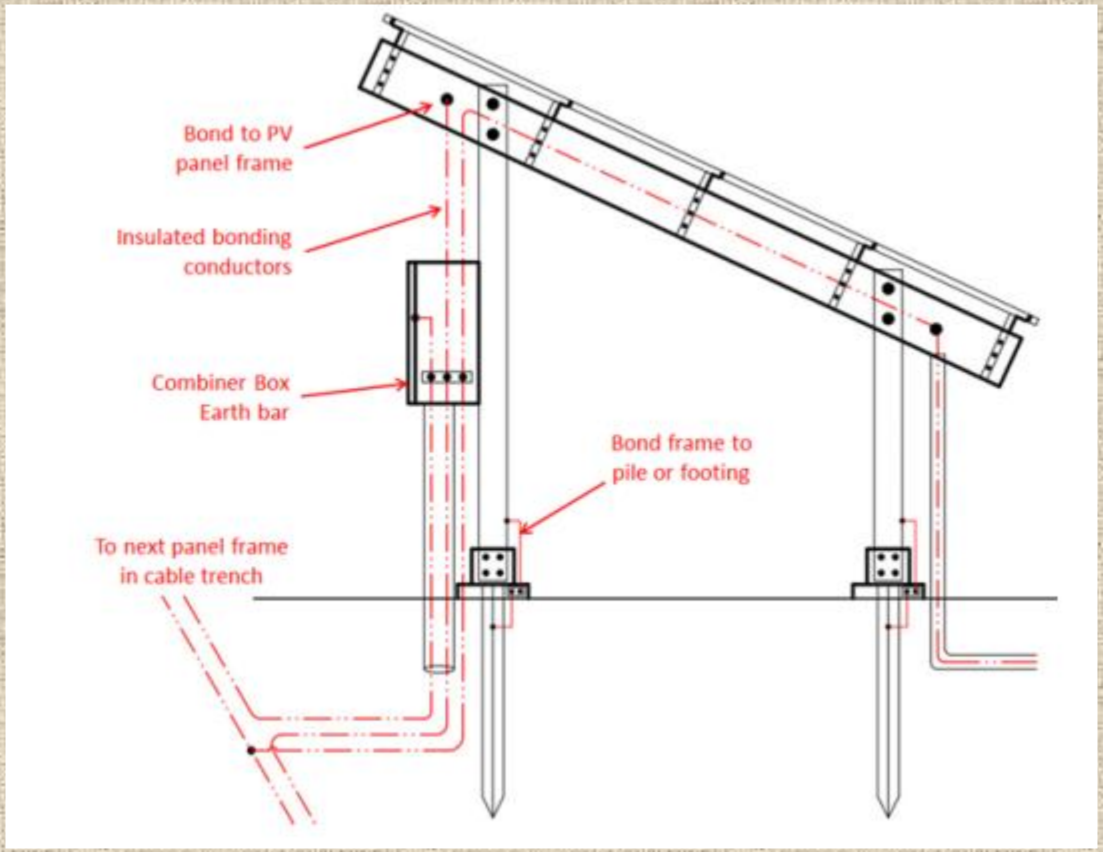
Earthing

Large solar plants consist of many Pv panels mounted on support frames with structure steel piles or footings . These form large arrays , connected together through DC systems to inverters ,feeding AC power to set-up transformers at specified export voltage .

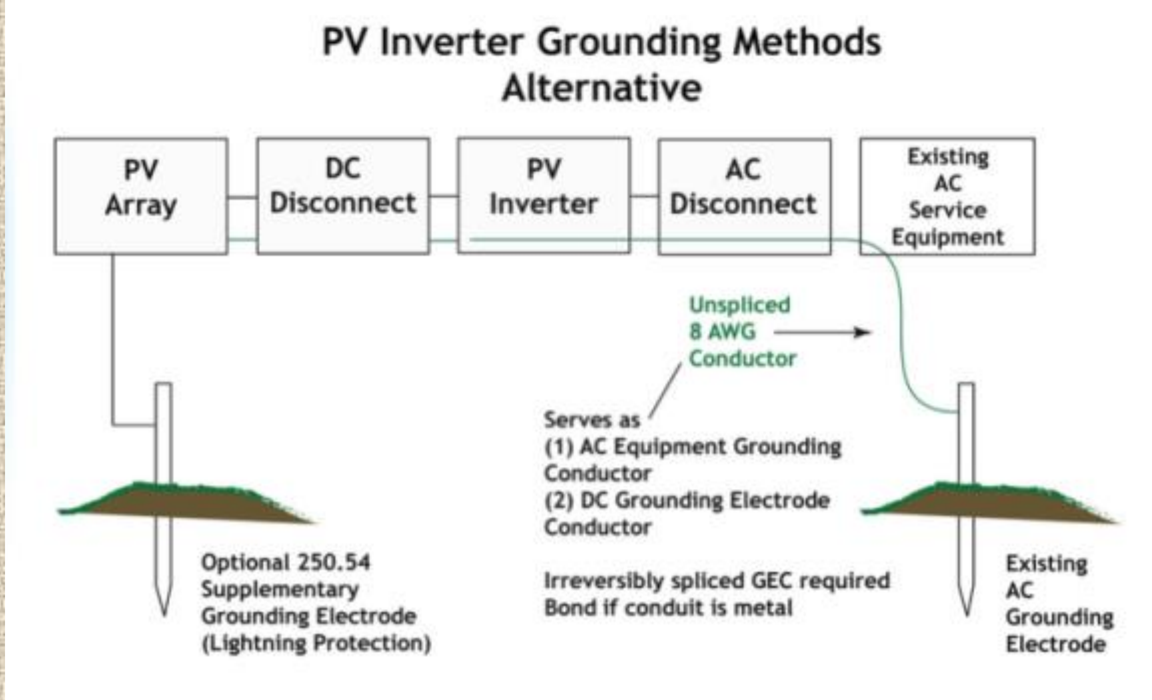
These means there are several district earthing systems that are interconnected and cover large area .

For designing software modelling is necessary .and one of the best offer for designing is **CDEGS**

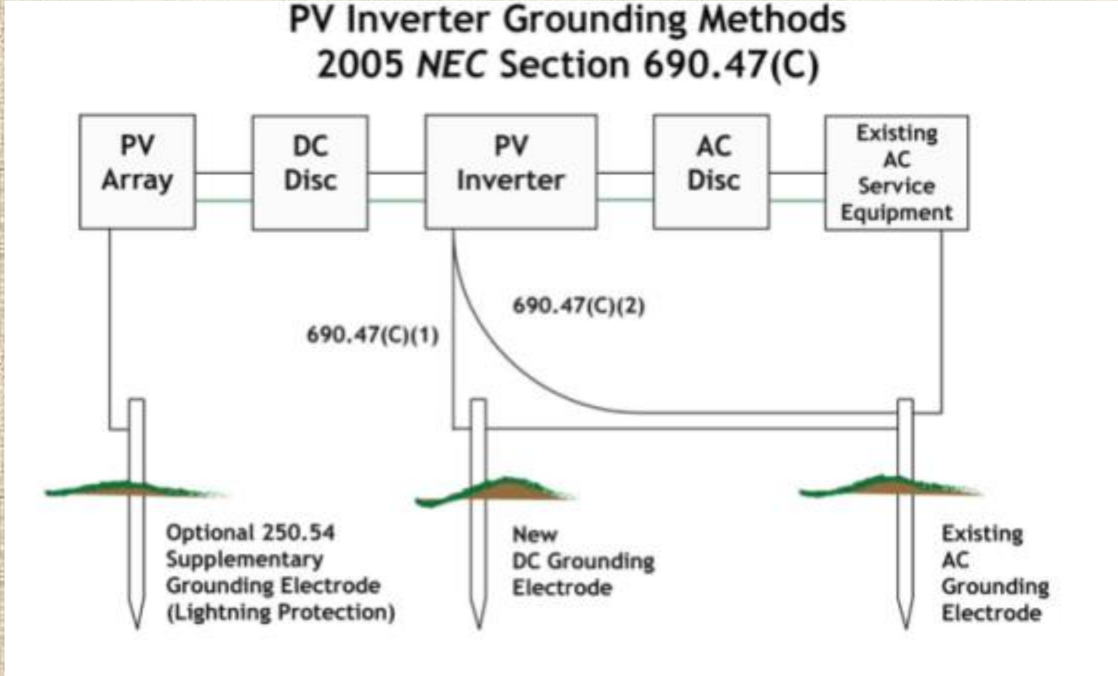
Earthing and bonding Method



Common DC grounding Electrode and AC grounding Electrode

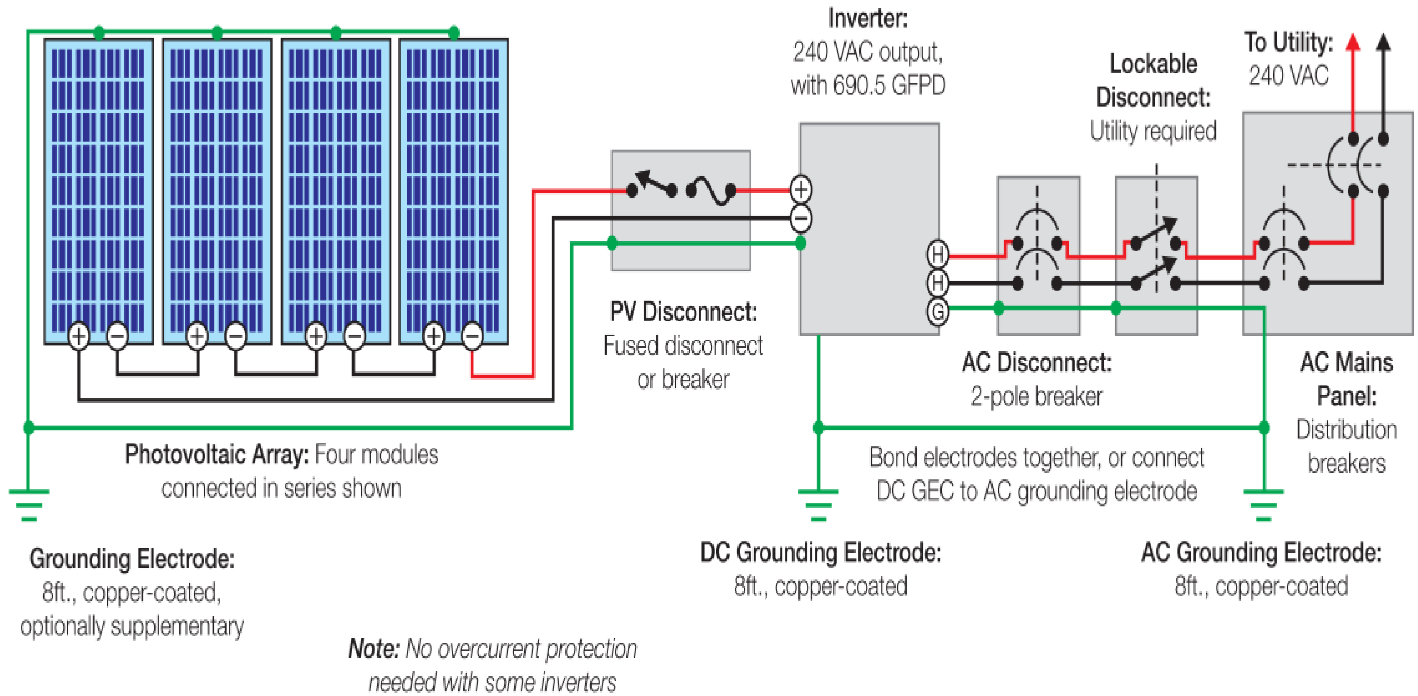


Separated DC grounding Electrode Bonded To the AC grounding Electrode

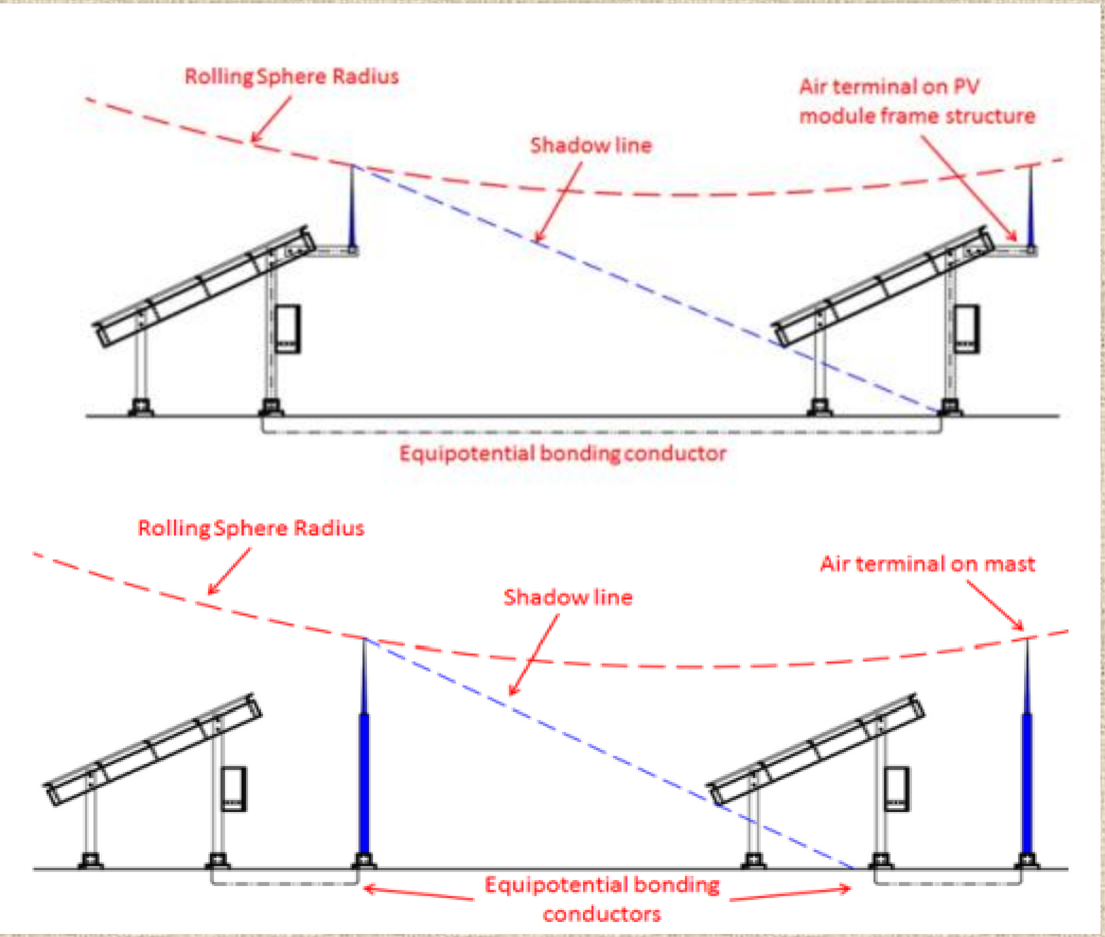


Grounding

grounding.



Lightning Protection



Nonisolated

IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY

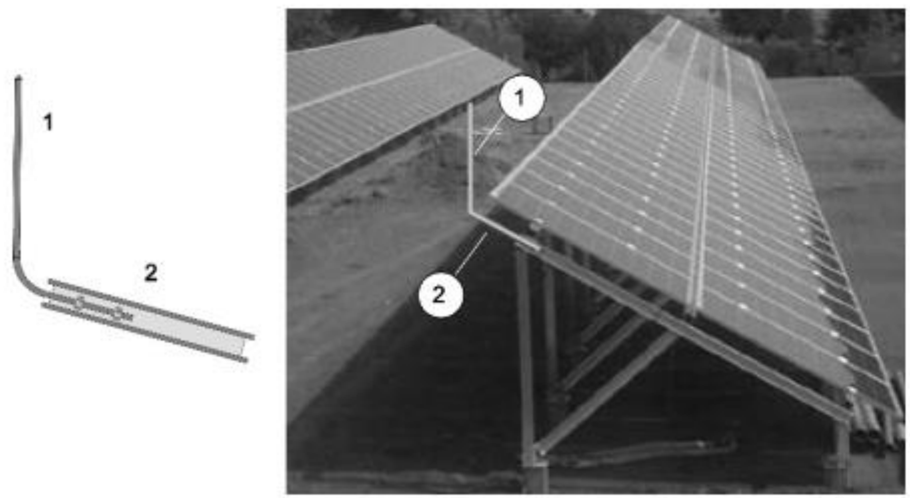


Fig. 2. Nonisolated L.P.S in PV applications. (1) Aluminum air termination rod. (2) Connection clamp.

Isolated

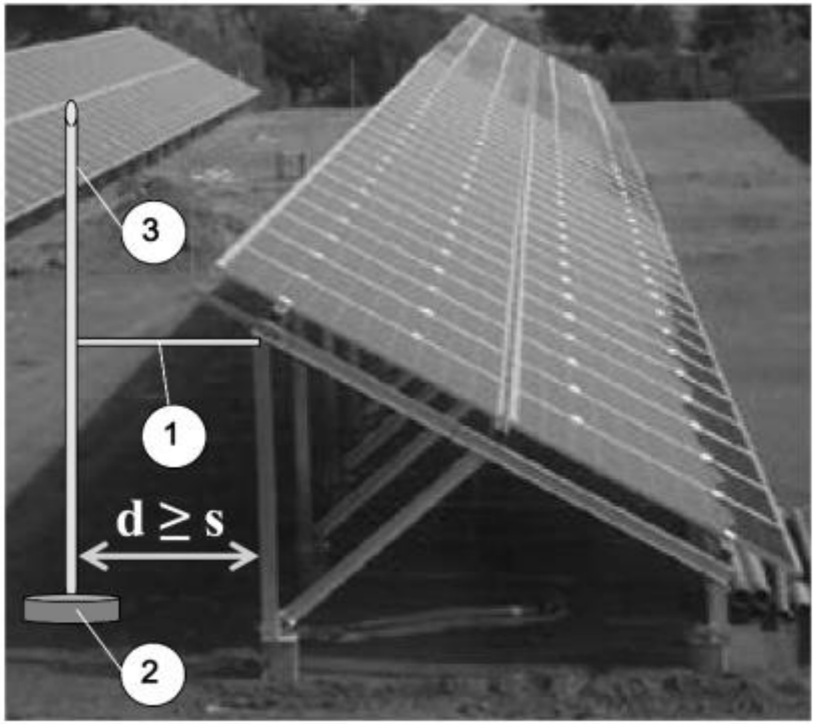


Fig. 1. Isolated L.P.S in PV applications. (1) Isolating support. (2) Concrete block base. (3) Air termination rod.

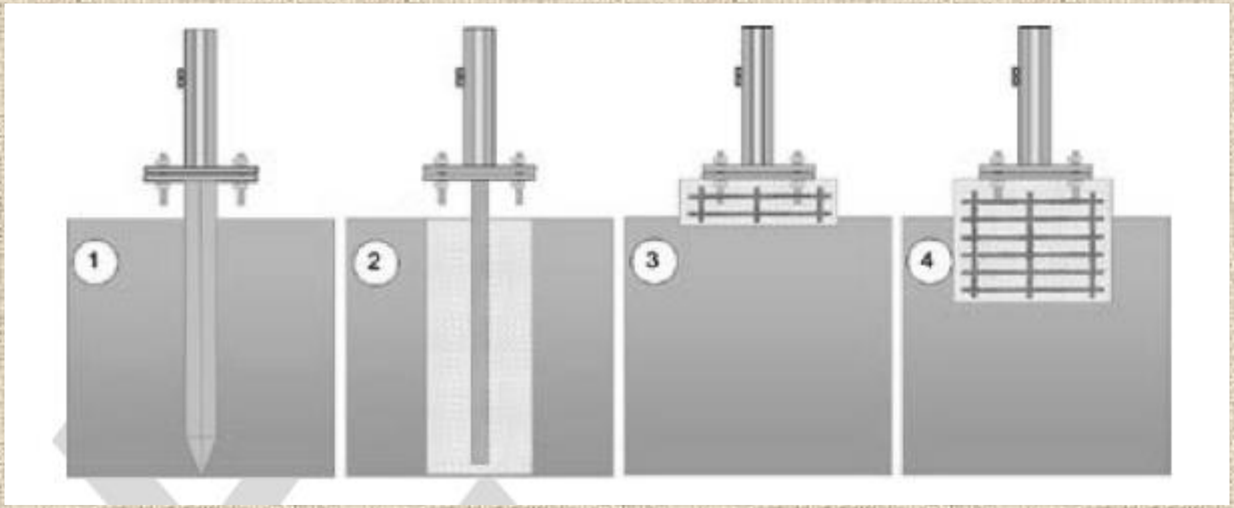
Separation distance

The separation distance d should always be greater or equal to a minimum separation distance s calculated as follows:

$$s = \frac{k_i}{k_m} \times k_c \times l \qquad (1)$$

where k_i is a constant that depends on the selected class of the L.P.S, k_m is a constant that depends on the electrical insulation material, k_c is a constant that depends on the (partial) lightning current flowing in the air termination and the down conductor, and l is the length, in meters, along the air termination and the down conductor [6]. Distance l spans from the top level of the PV

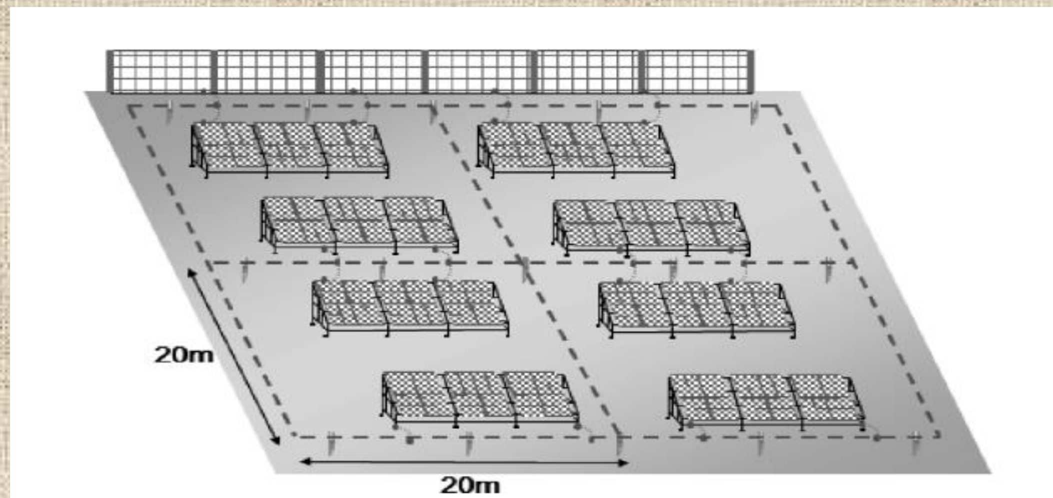
Type of foundation for earthing systems

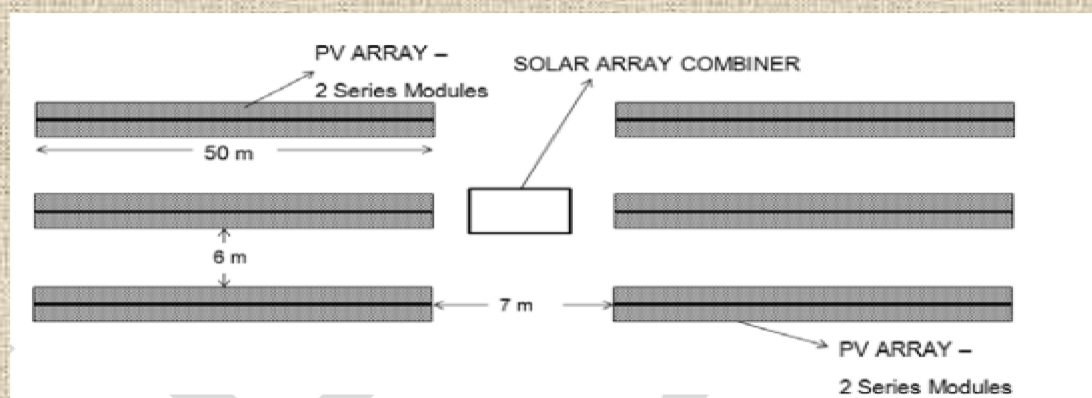


Aluminum not allowed to be buried into the soil

Type of Foundation	
1	Galvanized steel directly buried into the soil
2	Steel profile embedded in concrete
3	Reinforced concrete block placed above ground level
4	Reinforced concrete foundation into the soil

Grounding


20m
20m


PV ARRAY –
2 Series Modules
SOLAR ARRAY COMBINER
50 m
6 m
7 m
PV ARRAY –
2 Series Modules

LPS and earthing design

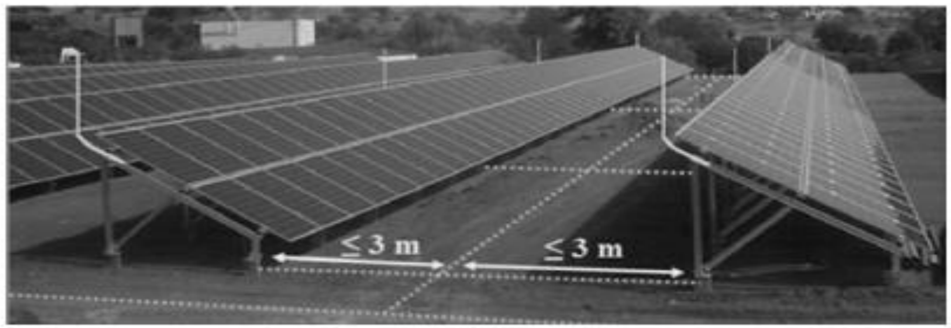


Fig. 7. Example of nonisolated L.P.S and earthing design for large-scale solar field applications.

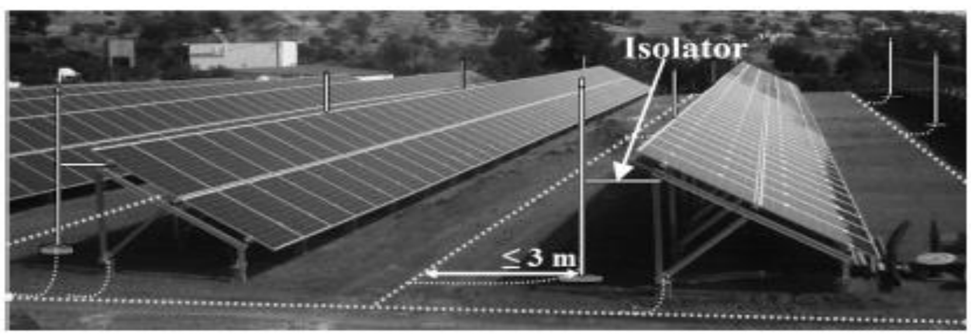
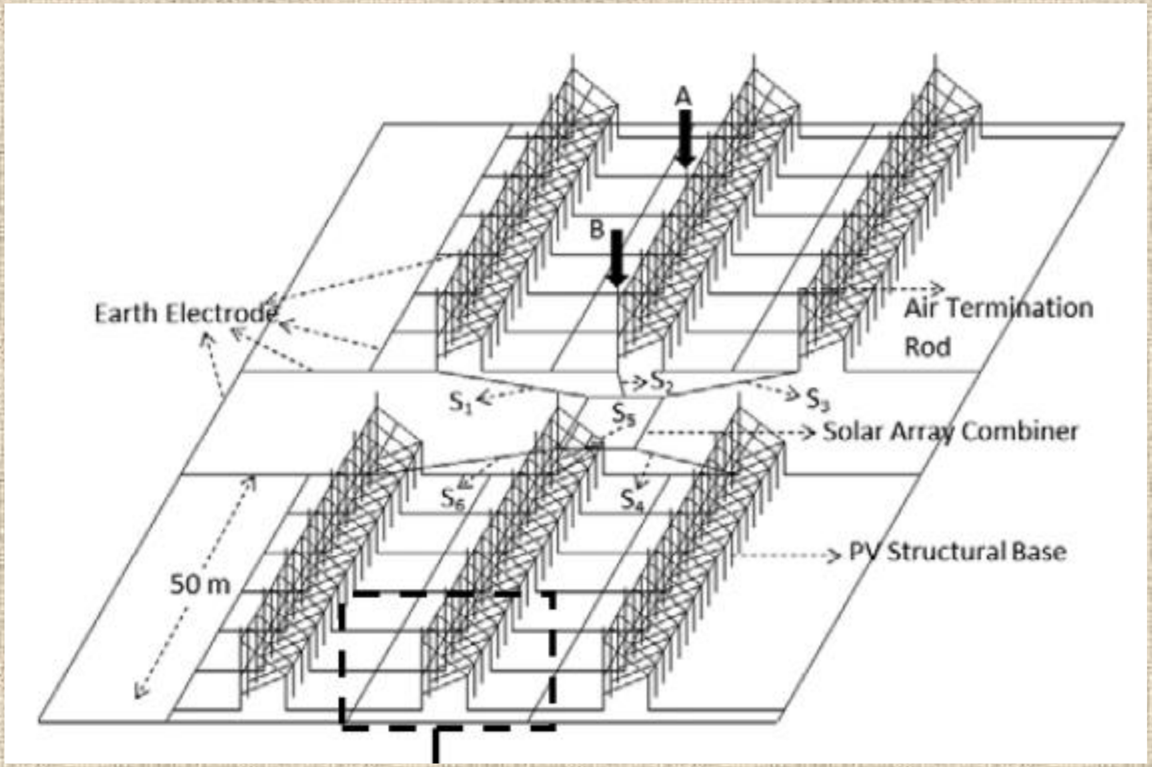


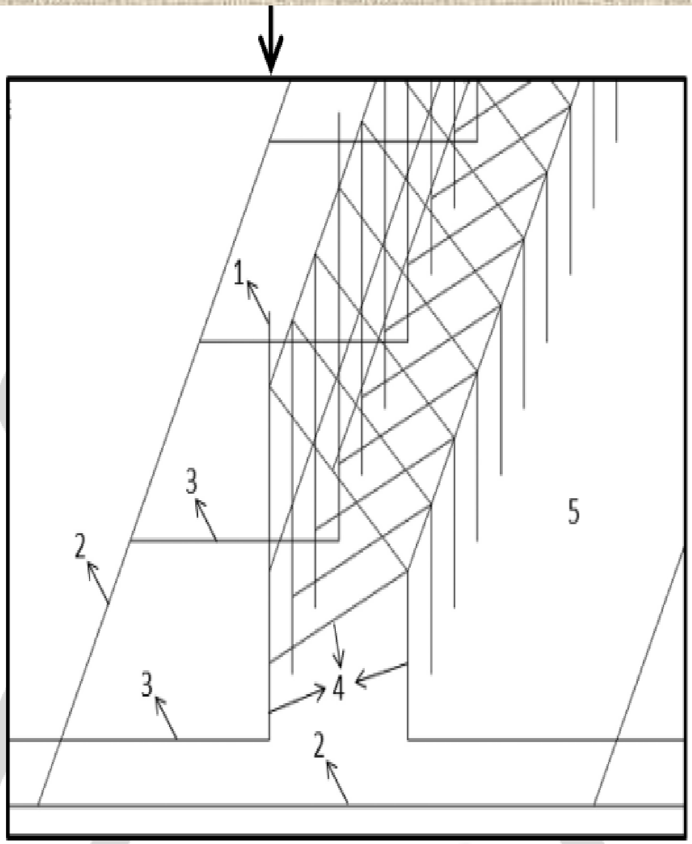
Fig. 8. Example of isolated L.P.S and earthing design for large-scale solar field applications.

LPS and earthing design



Simulation for 150 KW park

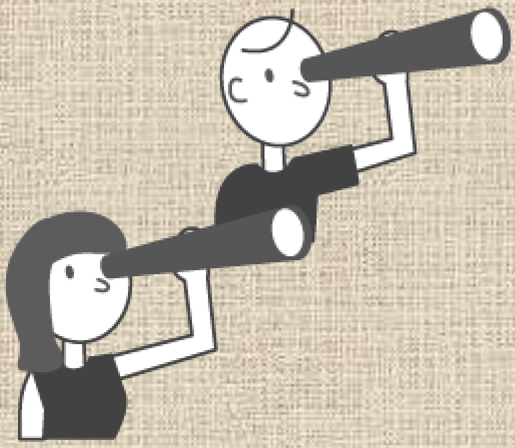
Numbered Items	Further Particulars
Attached Lightning Rod (Item 1)	Aluminium air termination rod, Φ16mm, 1m long, attached on the PV support structure. Designed as per Class I L.P.S [5] Number of Lightning Rods*: 7 Spacing*: ~7m *Evaluated as per IEC 62305-3 [16] (rolling sphere method)
Earth Electrodes (Items 2 & 3)	Earth electrodes are made of copper conductors (CSA 50mm^2) buried into soil at a depth of 0.5m. The structural PV base is bonded (item 3) to the circumference earth electrode (item 2) to ensure an equipotential continuity.
Structural Base (Item 4)	Geometrically accurate aluminium support PV structure as per the dimensions given in Fig 10. Each metallic component of the base is approximated by 10mm radius aluminium conductors. The vertical conductors (legs) of the structure are driven to a depth of 1.5m into the earth.
Soil (Item 5)	The soil resistivity is assumed to be 100 Ω.m.



Isfahan grounding

Scope of study :This study present an earthing that have been installed in the solar farm at Isfahan and supported all safety limits for equipment and personal described in relevent International standard

- HV Installations
- LV Installations
- Metallic structures
- Fencing



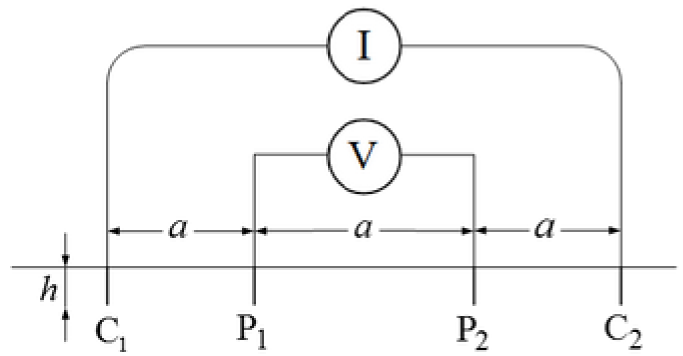
SOIL RESISTIVITY MEASUREMENTS

Wenner Method was followed for the measurement of the soil resistivity

Test No.	Soil Resistivity (Ω.m)				
	0.5 m	1 m	2 m	4 m	8 m
1	327	273	783	831	Rp Error*
2	893	873	1180	Rp Error*	Rp Error*
3	573	693	885	Rp Error*	1134
4	498	576	Rp Error	997	1023
5	721	Rp Error*	Rp Error*	823	879
6	554	443	Rp Error*	811	797
7	397	301	431	599	671
8	673	Rp Error*	893	921	Rp Error*
9	594	Rp Error*	Rp Error*	Rp Error*	Rp Error*
10	Rp Error*	591	Rp Error*	Rp Error*	763

Wenner

$$\rho = 2\pi a \times \frac{V}{I}$$

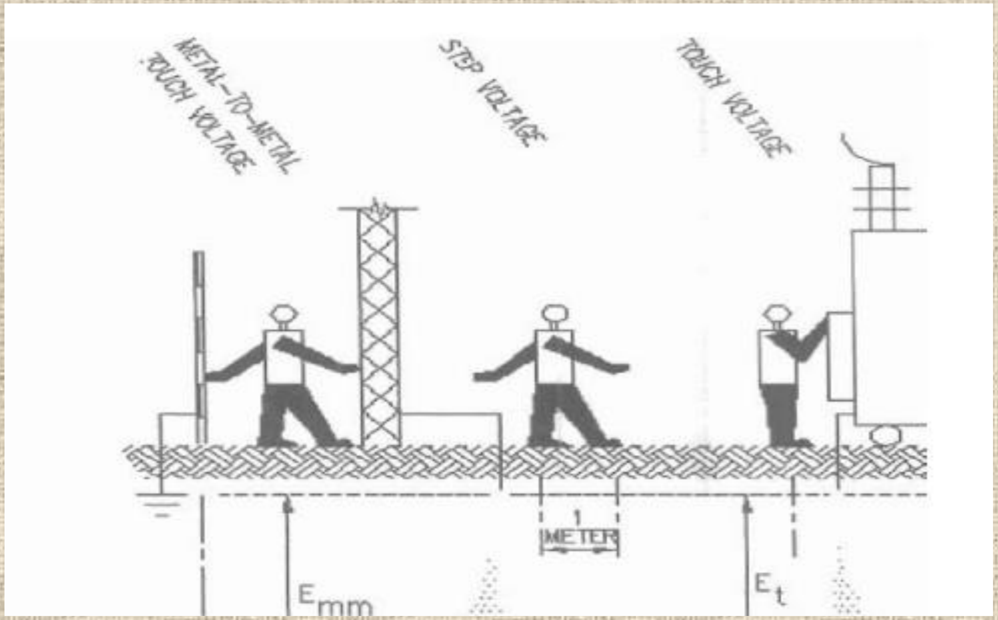


$$\rho = \frac{4\pi a}{1 + \frac{2a}{\sqrt{a^2 + 4h^2}} - \frac{a}{\sqrt{a^2 + h^2}}} \times \frac{V}{I}$$

Step and Touch Voltage

Step Voltage : is the potential difference between a people's outstretched feet, normally one meter apart, without the person touching any electrical structure.

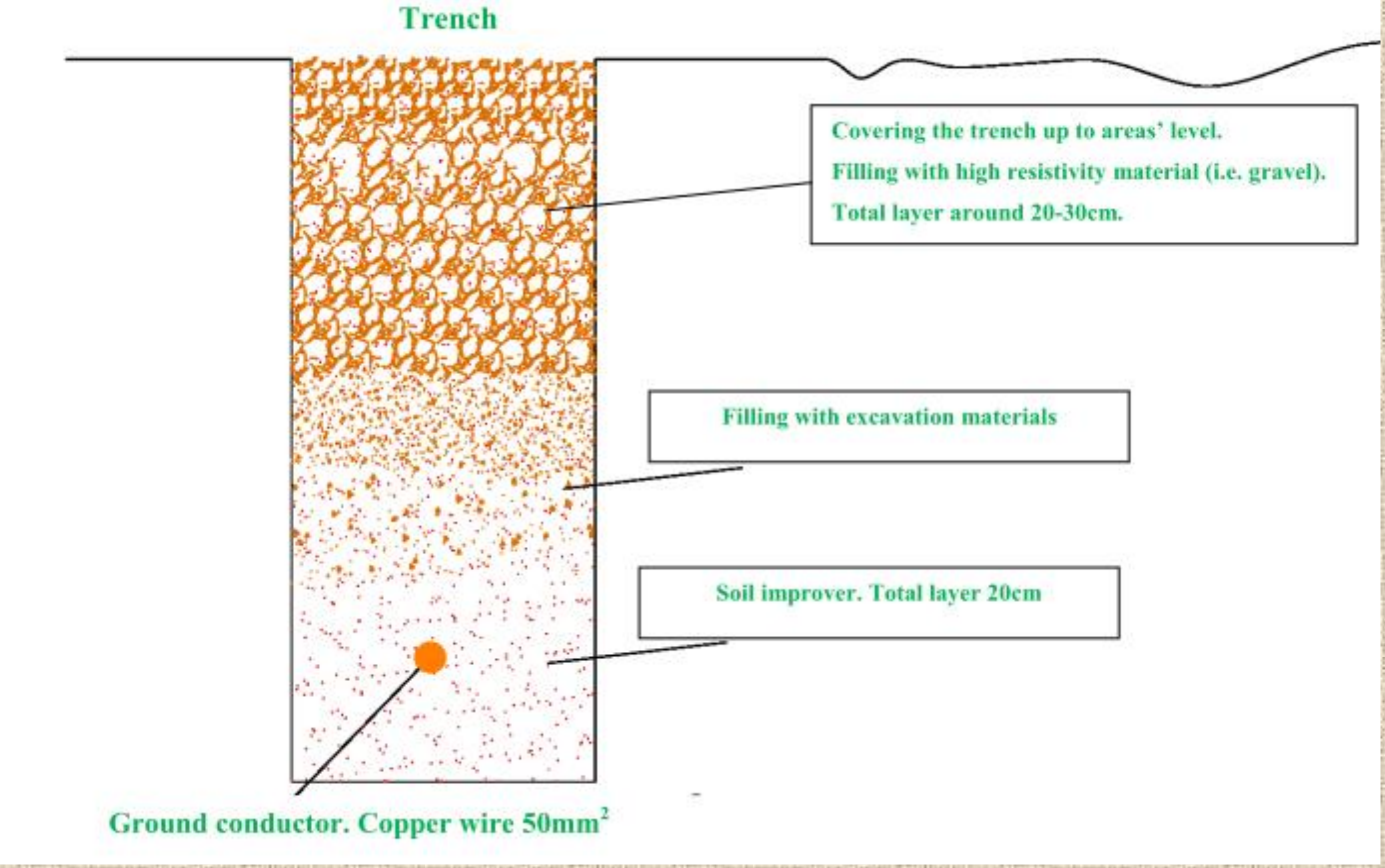
Touch Voltage : is the potential difference between a people's outstretched hand, touching an earthed structure and his foot.



Formation of the ground trenches

All ground trenches must be excavated in a depth of about 100 cm and 40 cm width. After the excavation, all trenches must be thorough cleaned from stones and rocks. Then a soil improver or wet low resistivity soil (if is available on site) with a layer of about 10cm width will be laid. After, the earth conductor will be laid and will be covered with the same soil improver (additional 10cm width).

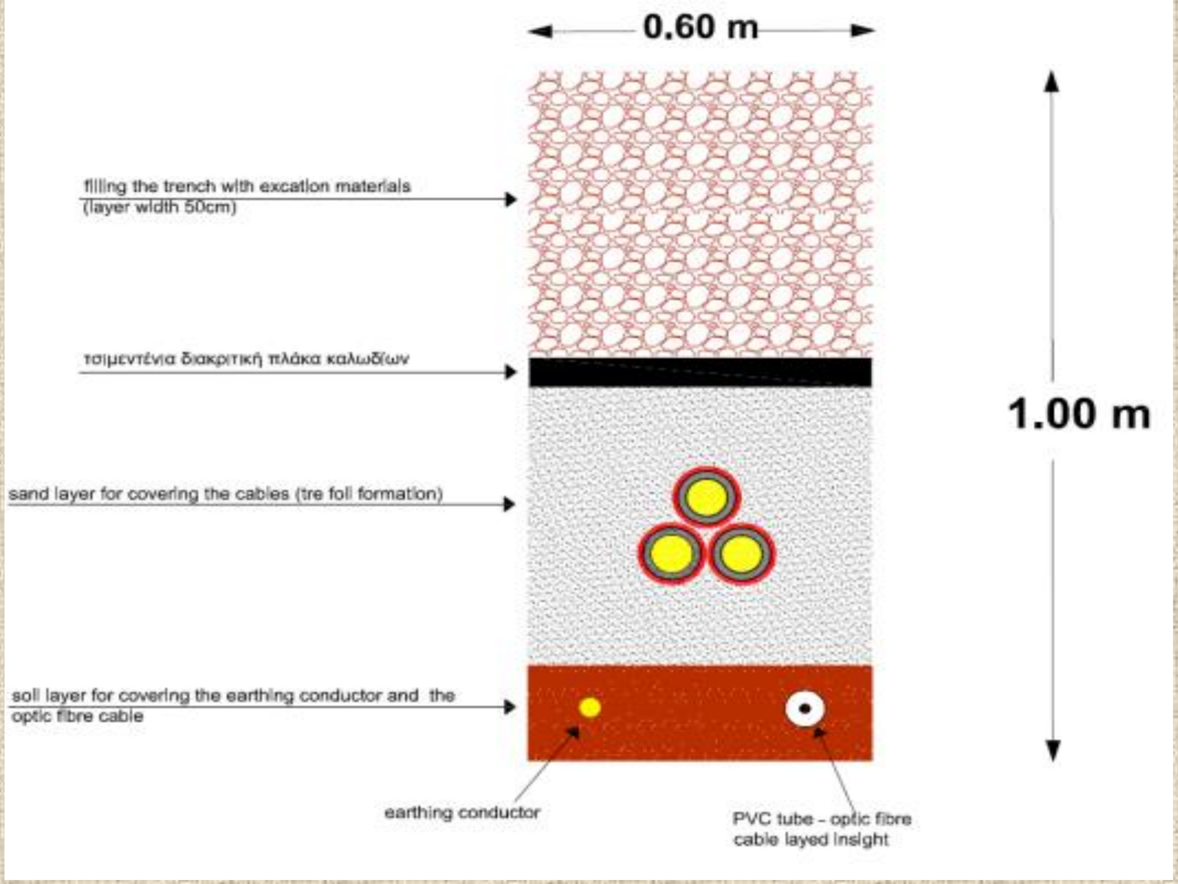
Formation of the ground trenches



Ground trenches and medium voltage cable routing

In the areas where medium voltage cables must be laid in order to connect the substations, it is proposed to combine the cable trenches with the earthing trenches in order to save time, space and cost. In the following scheme a combined trench of this kind is presented.

Ground trenches and medium voltage cable routing



Metallic fencing of the park

It is proposed that the metallic fencing should not be connected with the parks earthing grid. The reason for this proposal is to avoid possible high touch and step voltage that could be developed especially in the edges of the fences in case of a ground fault.

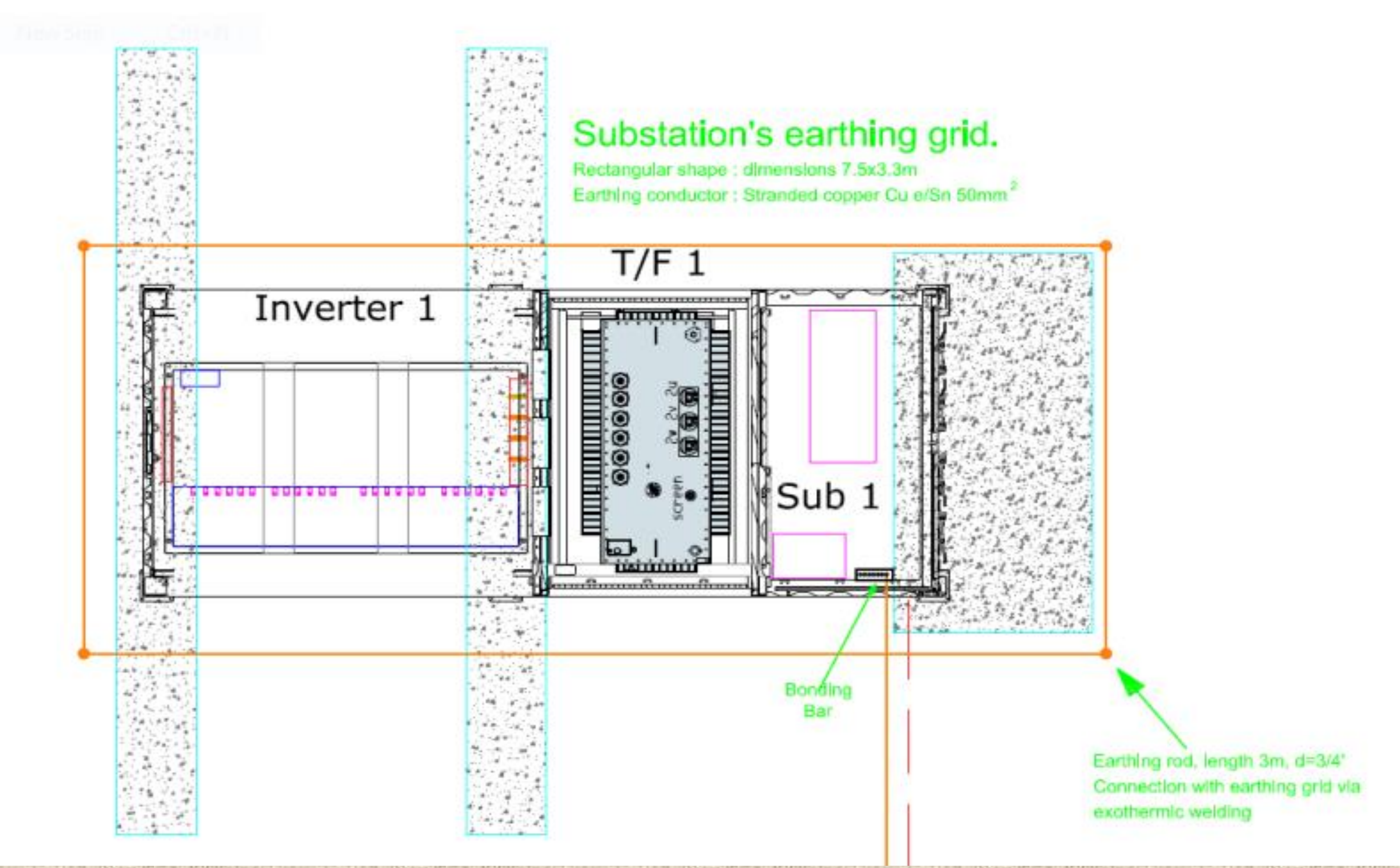
Medium voltage cables metallic sheath connection

Details of the medium voltage substations earthing grid

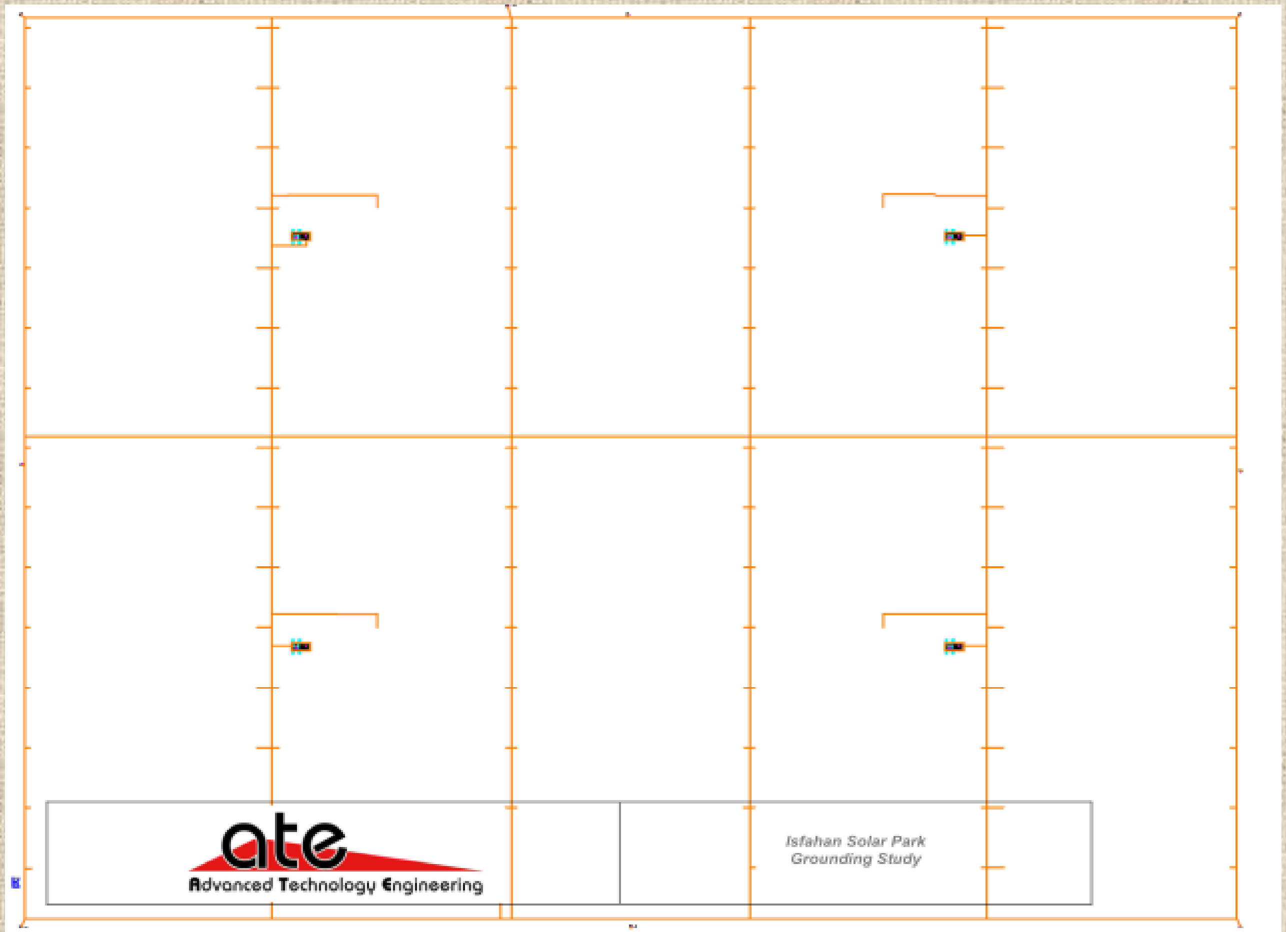
In the perimeter of the four substations an earthing grid will be placed. The grid will have a rectangular shape with outer dimensions 7.5x3.3m In each of the four corners of the rectangular shaped grid a ground rod will be placed. The rod he electrodes must have 1.5m length and a cross section of ¾" and will connected to the loop using a type of exothermic welding. Insight the substation, a grounding bonding bar must be installed. In the bonding bar the following must be connected

1 AC neutral grounding conductor
2 Transformer's metallic tank
3 Earthing grid conductor
4 Connection with the fundamental earth of the substation

medium voltage substations earthing grid



Earthing Grid



Details and material

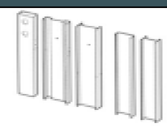
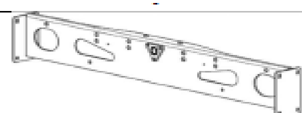
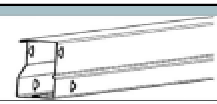
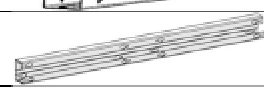
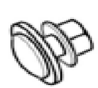
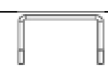
Number of Ground Rods:	16
Total Length of Ground Conductors:	4625.00 m
Total Length of Ground Rods:	24.00 m

Materials

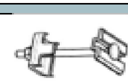
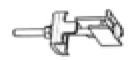
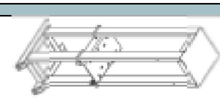
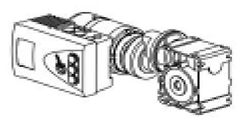
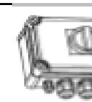
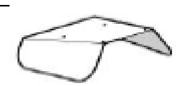
MATERIALS		
GROUNDING		
PERIMETER EARTHING AND INTERNAL CONNECTIONS		
Earth Rod Φ 16x1.5m (3/4") for Substations Grounding	pcs	25
Copper conductor 1x50mm^2 **(Hard Drawn Copper according to BS 7884)**	m	5223
PERIMETER EARTHING AND INTERNAL CONNECTIONS(CLAMPS)		
Clamp copper conductor 50mm^2 - Copper Earth Road Φ16	pcs	26
Clamp copper conductor 50mm^2 -Clamp copper conductor 50mm^2 "T" (exothermically welded)	pcs	92
Clamp copper conductor 50mm^2 -Clamp copper conductor 50mm^2 "T" (exothermically welded) - Trackers	pcs	76
Clamp copper conductor 1x50 - copper conductor 1x50 "parallel" (exothermically welded)	pcs	17
Clamp copper conductor 1x50 - reinforcing (exothermically welded)	pcs	26
Various		
Bare Copper Conductor 120mm^2	m	202
Clamp copper conductor 50mm2 - copper conductor 120mm2 "T" (exothermically welded)	pcs	38
Bare Copper conductor 95mm^2	m	26
Clamp copper conductor 50mm^2 - copper conductor 95mm^2 "T" (exothermically welded)	pcs	9

Parts description

3.1 Parts description

Designation *Reference*		Mass (kg)	Installation step	Qty / step
End piles: Pile C170 *026P174X*		<10 kg/m <15 kg/m	Pile installation	2
Central piles: Pile 6'x4' *026P649X*		<15 kg/m <15 kg/m	Pile installation	1
Axle support HZ *026P2000*		<5	Axle supports and rocking units mounting	6
Bolt M12x35 Class 12-9	-	<1	Axle supports and rocking units mounting	6
Narrow washer D12	-	<1	Axle supports and rocking units mounting	12
Prevailing torque nut M12 Class 8	-	<1	Axle supports and rocking units mounting	6
Ball joint spacer HZ *023P21XX*		<1	Axle supports and rocking units mounting	6
Bolt M20x130	-	<1	Axle supports and rocking units mounting	3
Prevailing torque nut M20	-	<1	Axle supports and rocking units mounting	3
Narrow washer D20	-	<1	Axle supports and rocking units mounting	6
Rocking unit short / long *026A3003 / 026A3004*		<10	Axle supports and rocking units mounting	3
Girder *026P5106*		<5 kg/m	Girders mounting	4
Girder link *026P5006*		<10	Girders mounting	2
Bolt TRCC M10x20 Geomet 500 Flange nut M10 Geomet 500 Normal washer D14 Geomet 500 <u>Kit option</u> Girder link fixation kit *026P5200*		<1	Girders mounting	32
Girder U bolt *026P6200*		<1	Girders mounting Mechanical transmission mounting	12 4
Prevailing torque nut M10	-	<1	Girders mounting Mechanical transmission mounting	24 14

Parts description

Bolt M6x90	-	<1	Mechanical transmission mounting	1
Prevailing torque nut M6	-	<1	Mechanical transmission mounting	1
Module middle clamp *026P5408* Girder clamp *026P5304* Bolt TRCC M6x80 Flange nut M6		<1	Modules mounting	36[1]
Module end clamp *026P5406* Girder clamp *026P5304* Bolt TRCC M6x80 Flange nut M6		<1	Modules mounting	4
Motor support *023A6450*		<20	Motor support and motor mounting	1
Anchoring stud M10x120	-	<1	Motor support and motor mounting	4
Large washer D10	-	<1	Motor support and motor mounting	8
Motor		<20	Motor support and motor mounting	1
Bolt M8x30	-	<1	Motor support and motor mounting	8
Normal washer D8	-	<1	Motor support and motor mounting	12
Prevailing torque nut M8	-	<1	Motor support and motor mounting	4
Emergency stop *023-AU*		<1	Motor support and motor mounting	1
Self drilling screw M5,5x25	-	<1	Motor support and motor mounting	8
NG Motor cap *026P7650*		<2	Motor support and motor mounting	1
NG Motor cap support *026P7650*		<1	Motor support and motor mounting	2
Drive bar *023P444X*		<2/m	Drive bars mounting	20[2]
Steel wire Ø3 hot deep galvanized	-	<6kg/100 m	Sling mounting	NA

[1] Quantity based on a table of 18 modules
[2] Quantity based on a tracker of 20 tables

Mechanical structure

Mechanical structure with modules (for reference only)

Installation step

exosun **INSTALLATION GUIDE EXOTRACK HZ V2**

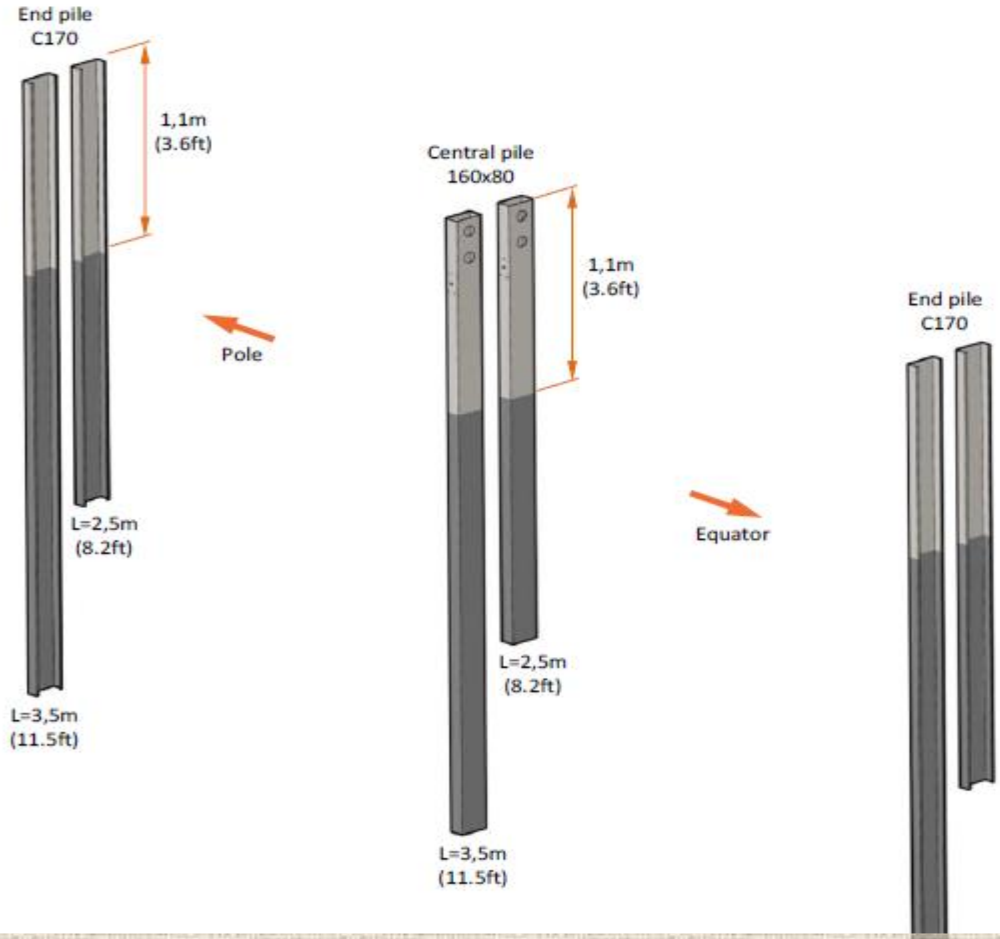
ISFAHAN V1 | 15/45

3.3 Structure installation steps

1. Piles installation
2. Foundation for motors supports
3. Piles pointing and drilling
4. Rocking units and axle supports mounting
5. Girders mounting
6. Mechanical transmission mounting
7. Modules mounting
8. Motor support and motor mounting
9. Drive bars mounting
10. Cable routing

Pile

Each row is mounted on three piles (one center pile and two end piles). These piles may have different secti
according to the project design loads. The coated side will be driven into the soil.



Pile tolerances

3.3.1.2 *Pile tolerances*

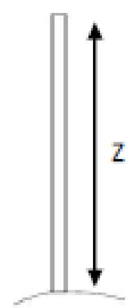
Distances between piles are given in the structure drawing associated to the project.

3.3.1.2.1 *Altimetry*

- Height from the ground

  For every pile: **Zmax < 1.4m (<55")**

  For central piles: **Zmin > 1.10m(>40.5")**



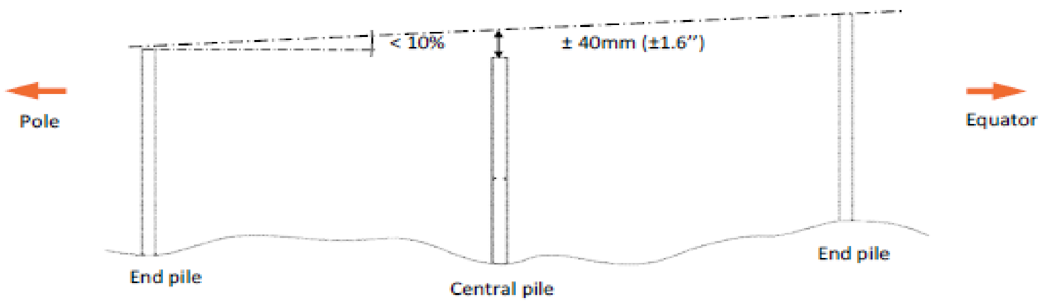
Pile tolerances

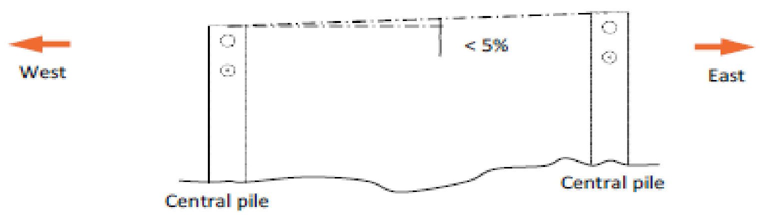
- Height according to the central pile

The 3 piles of one table must be aligned in height with a tolerance of **± 40mm (±1.6'')**

3.3.1.2.2 Slopes

- North / South: slope between the top of the two end piles **< 10%**
- East / West: slope between two neighbor central piles **< 5% (10% if option universal joint)**

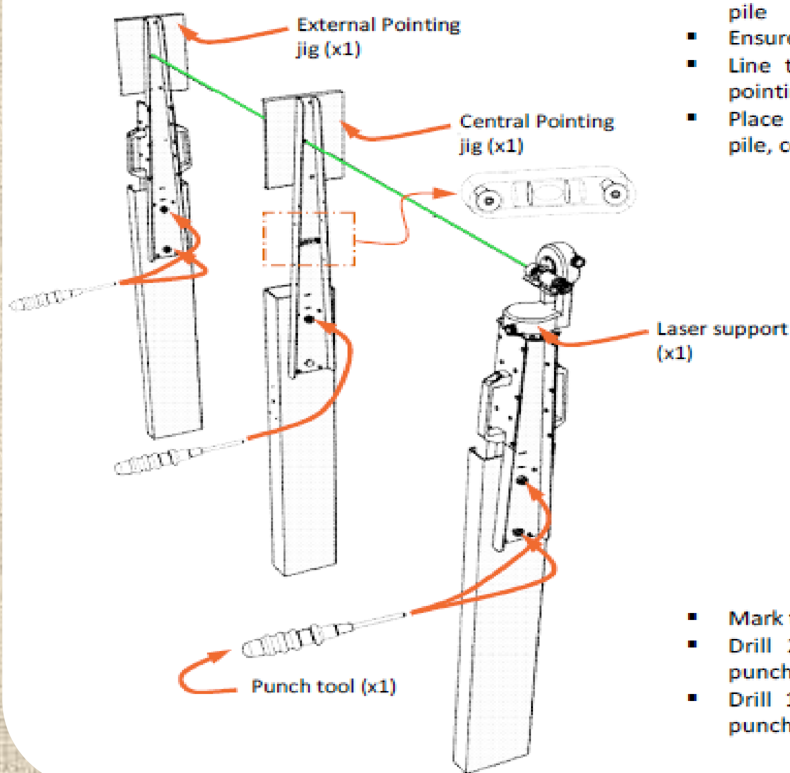




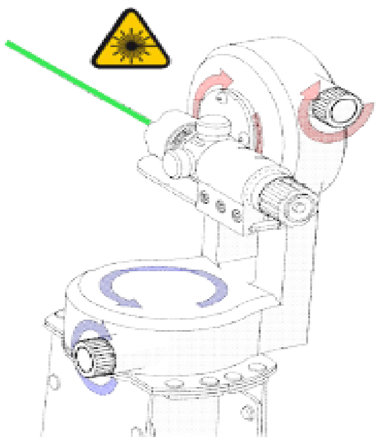
Pile pointing and drilling

.3.3 Piles pointing and drilling

Magnetic drilling machine (x1), Countersink cutter Ø12mm (x1), Central Pointing jig (x1), External pointing jig (x2), Punch tool (x1), Laser (x1)



- Position the central pointing jig on the central pile
- Ensure the central pointing jig is vertical
- Line the laser on the center of the central pointing tool
- Place the external pointing tool on the end pile, center it on the laser spot



- Mark the piles with the Punch tool
- Drill 2 holes Ø12mm per end pile on the punched marks
- Drill 1 hole Ø12mm per central pile on the punched mark

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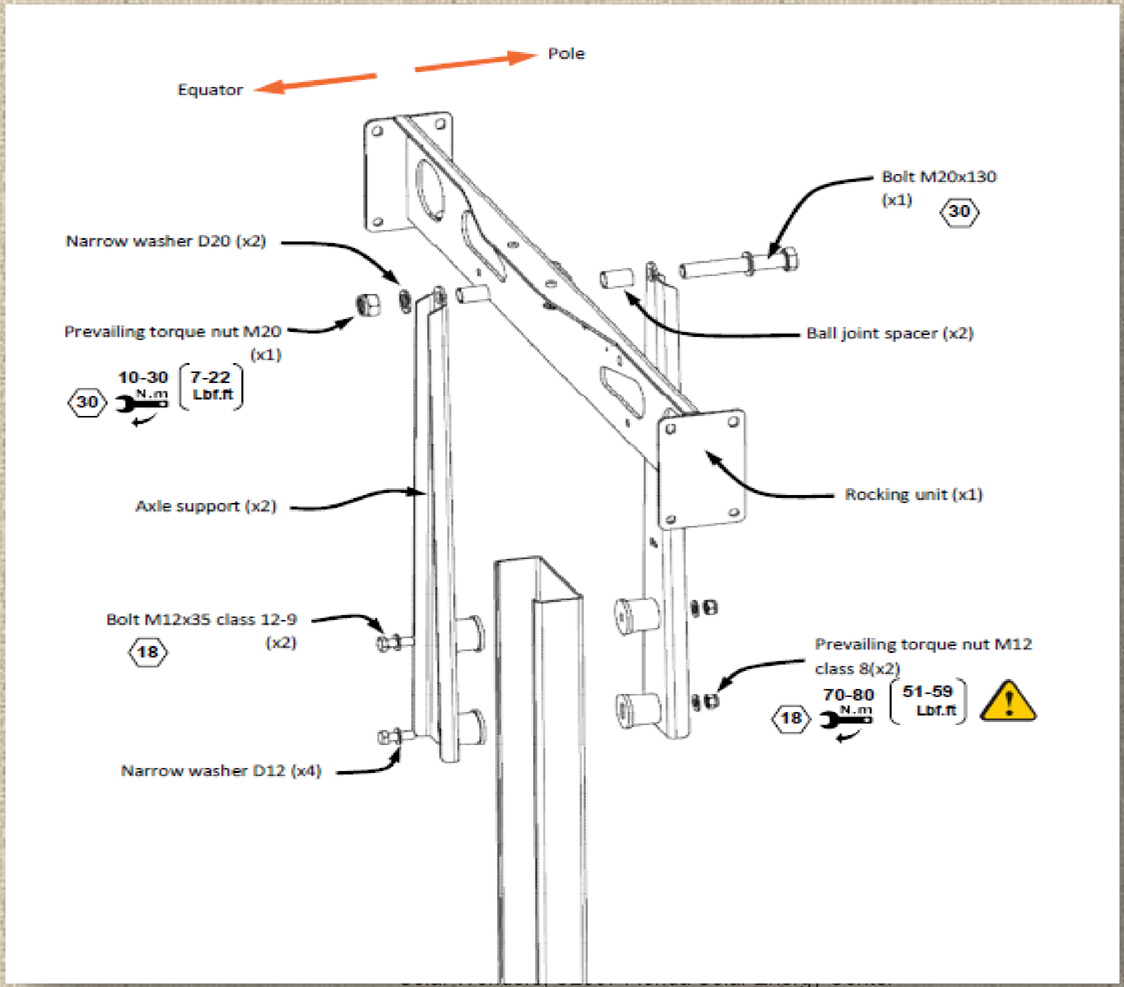
Racking unit

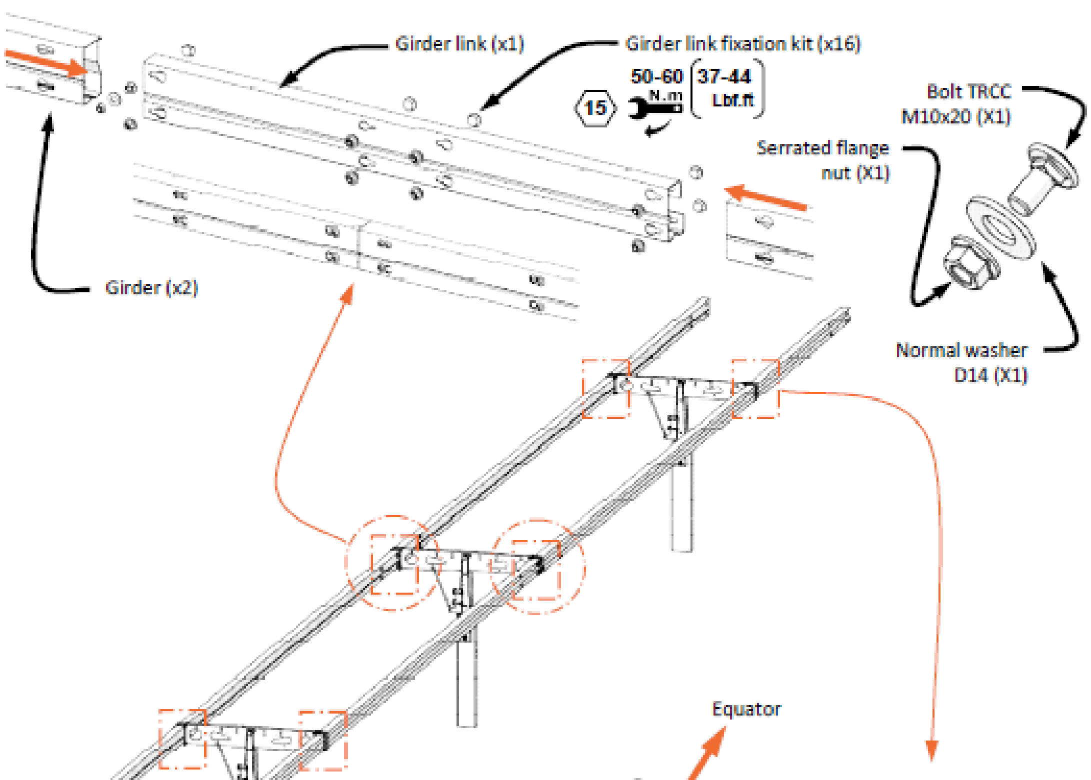


girders

3.3.5 Girders mounting

Strut tool (x3)
Long-reach 17mm socket recommended (x1)

- Lock the rocking units visually horizontally with the strut tools
- Position the girder link centered with the central rocking unit plate.



Modules mounting

3.3.7 Modules mounting

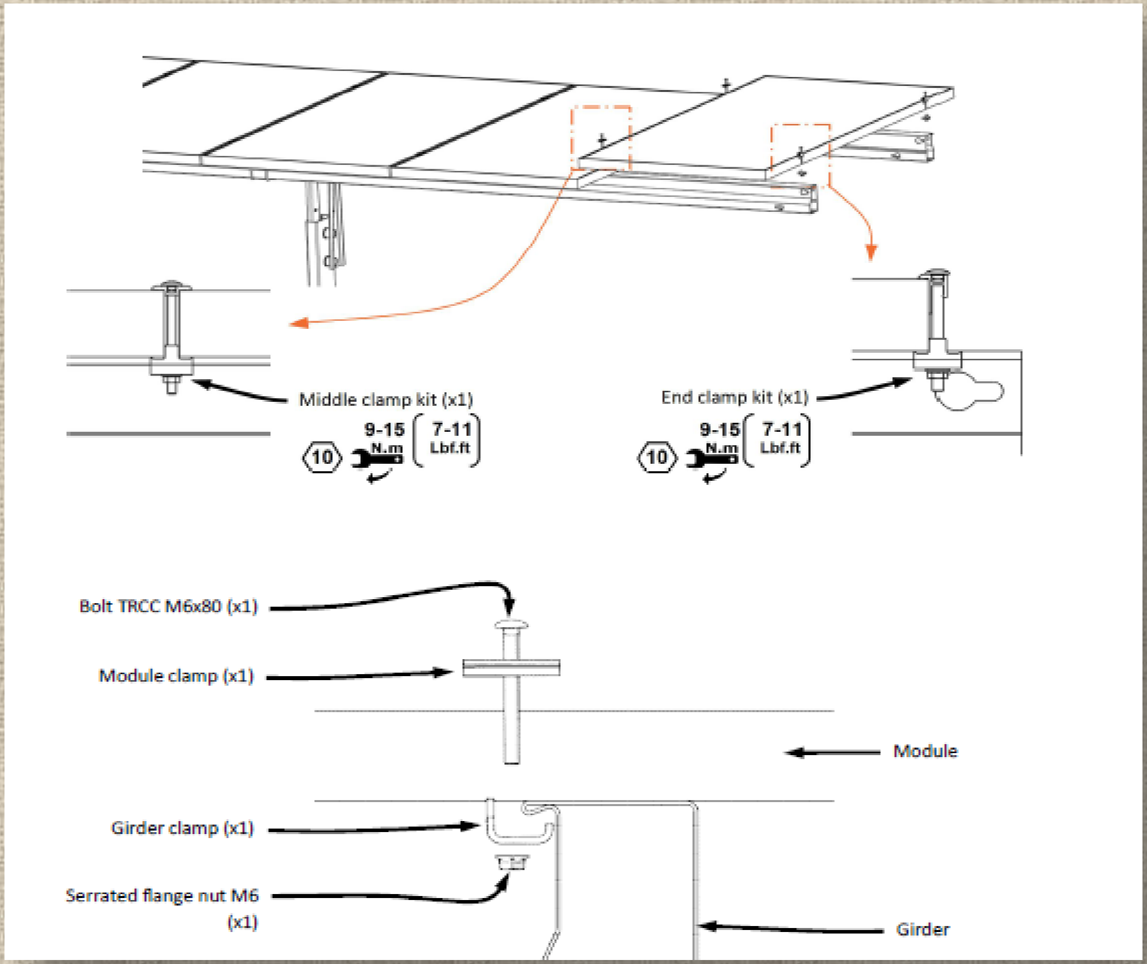
- Alternate the orientation of the modules in order to balance the table, with the same number of connection boxes on East side than on West side.

For example (but many other balanced configurations are possible):

Please center carefully the modules on the table.
The table must be balanced at the horizontal position. (max misalignment = 15mm (0.6'')).
The following steps describe one mounting method which gives good results, many other metods are possible.

- Mount the modules above the external rocking unit centered (max misalignment = 15mm (0.6'')). These 2 modules give the alignment reference. Their longitudinal position will be changed later.
Instead of module, it's possible to use 2 Betsy clamps or specific tools.

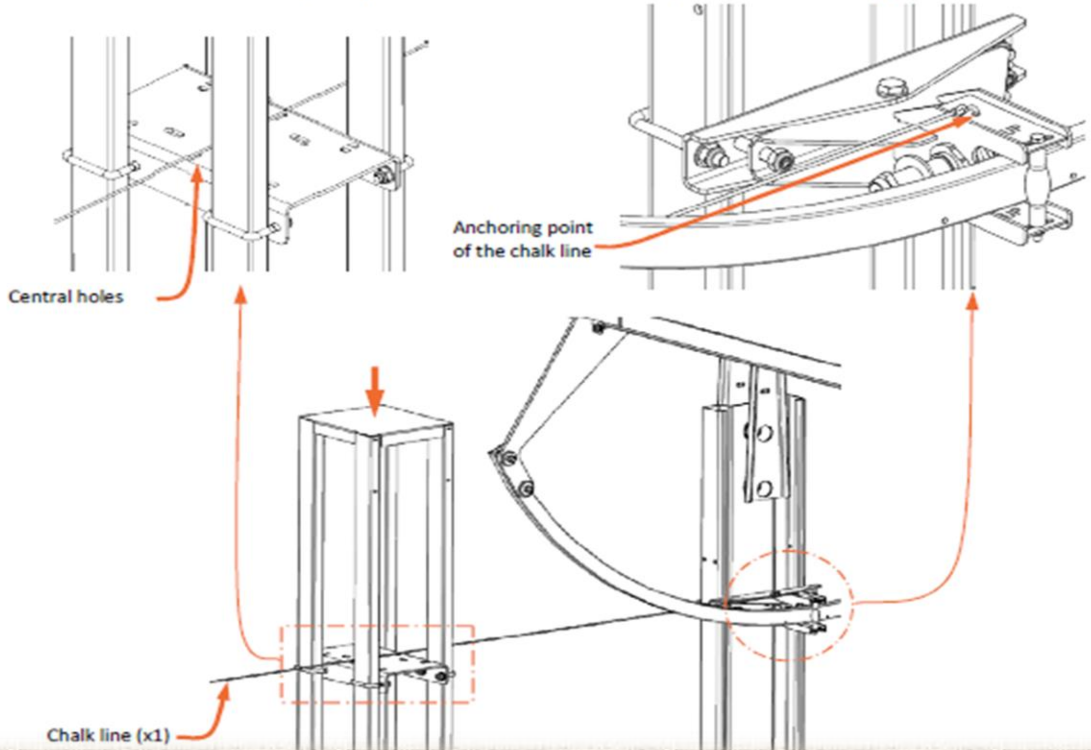
Modules mounting



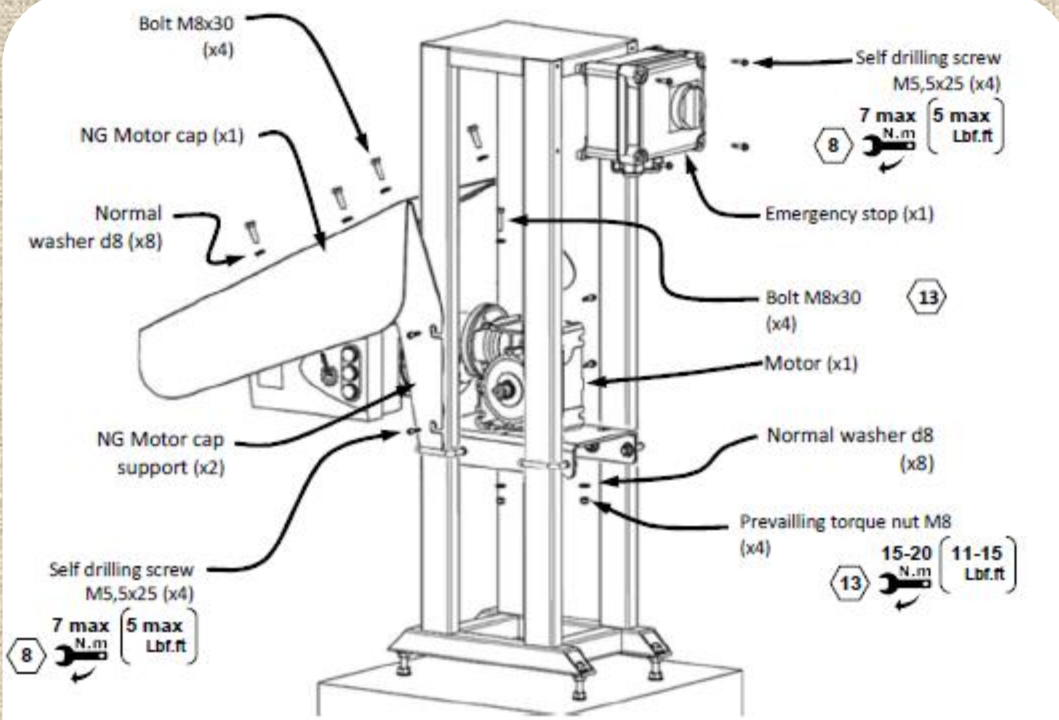
Motor support

Drilling guide tool (x1)

- Set the Drilling guide on the slab and put the motor support on it.
- Stretch out a chalk line between the 2 daily tracking units of the neighboring tables while routing the chalk line through the motor support.
- Position the motor support to ensure:
  - The alignment between the chalk line and the central holes of the plate
  - A distance of 1030mm (40.5'') between the axis of the central pile and the motor support.



Modules mounting

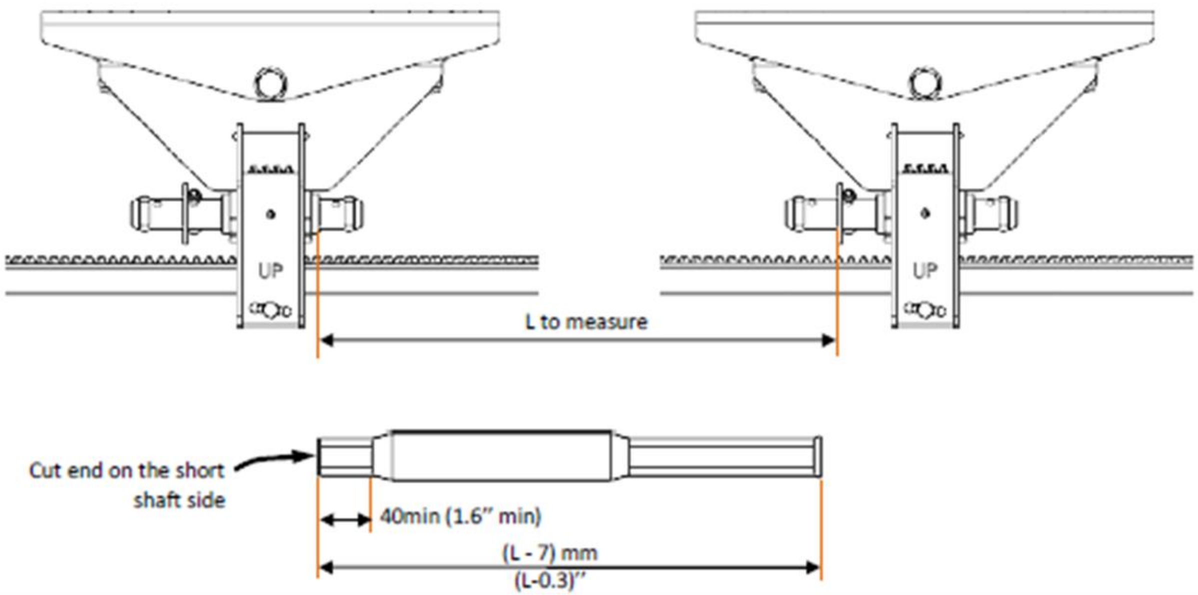


- Fix the motor shield 1cm (0.4") on top of the motor, assemble the fixation legs provided with the emergency stop and mount this one on top of the motor support.

Drive bars mounting

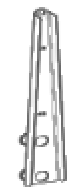
3.3.9 Drive bars mounting

- Ensure that the tables on the tracker are on stow position, by measuring central module inclination, it shall be at ±0.5°, on each table of the tracker
- Measure the L distance between the short shaft end and the long shaft washer. Cut one or 2 ends of the bar to match (L – 7)mm ((L-0.3)'').

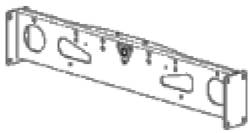


Mechanical Parts

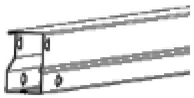
- Axle support HZ



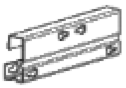
- Rocking unit short / long



- Girder



- Girder link



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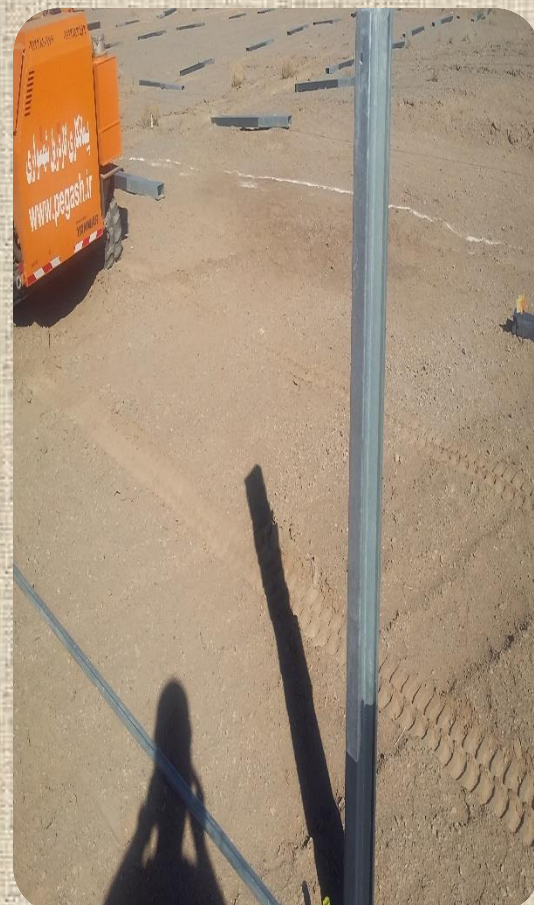
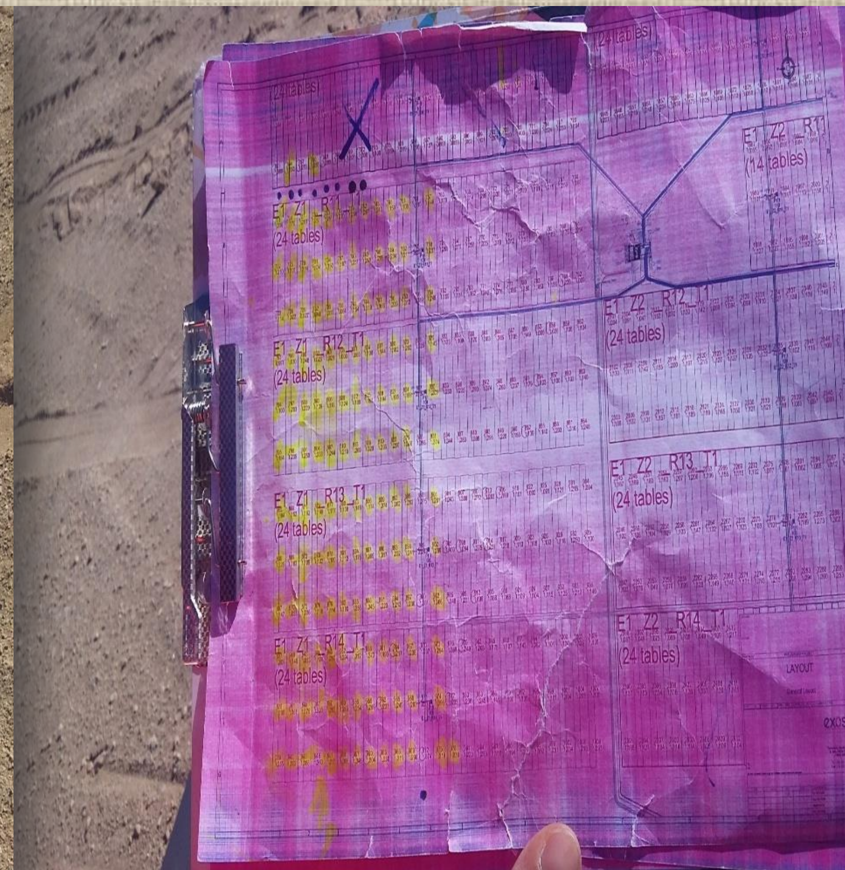
Piling machine



10 MW PV Plant Picture



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Girder

OM Building

Mohammad Parhamfar

Compound Area

Piling Machine

Pile

Mohammad Parhamfar

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Laser and leveling

Pile

Mohammad Parhamfar

Unloading

Unloading

Cabling

Cabling

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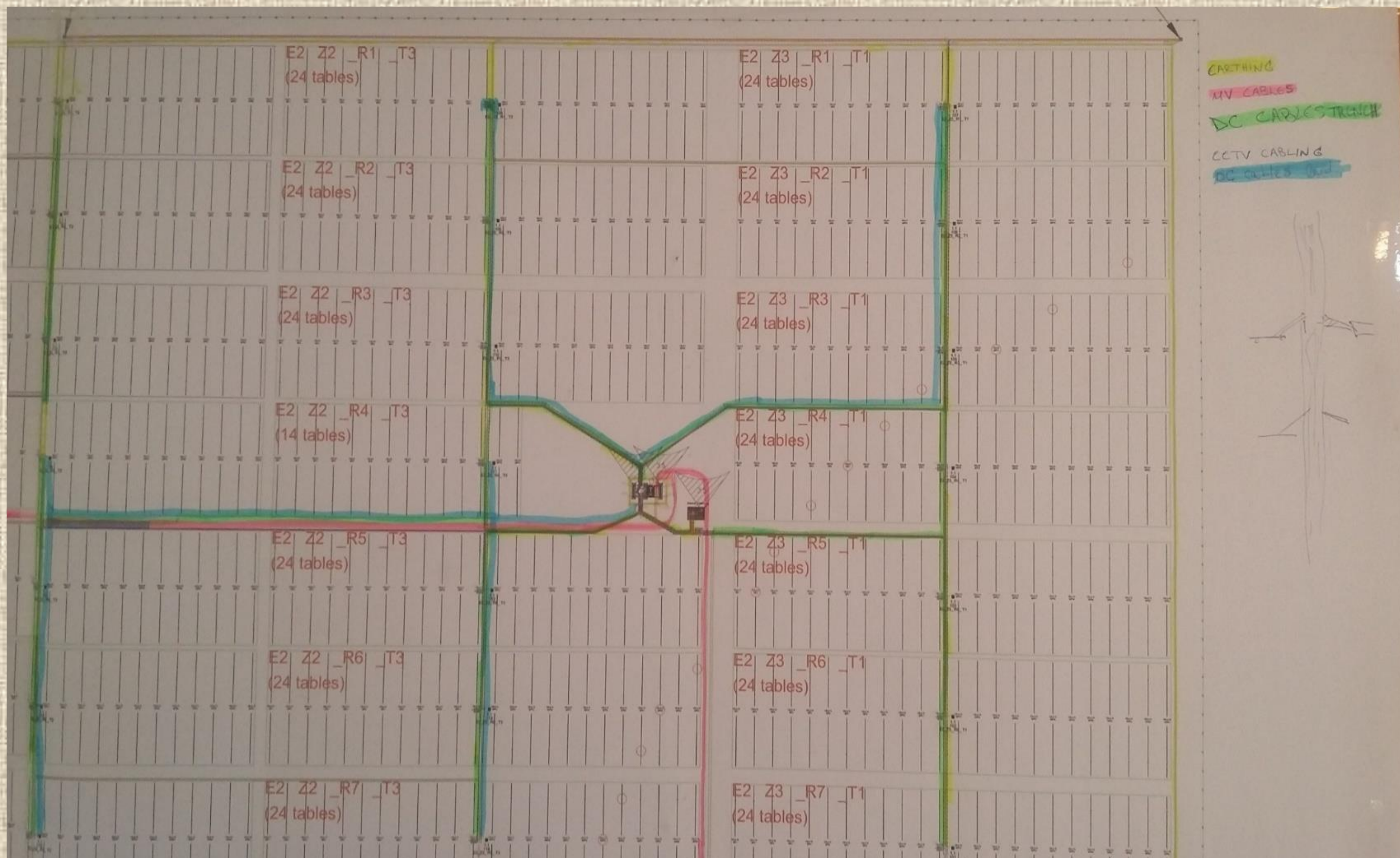
Unloading

Map



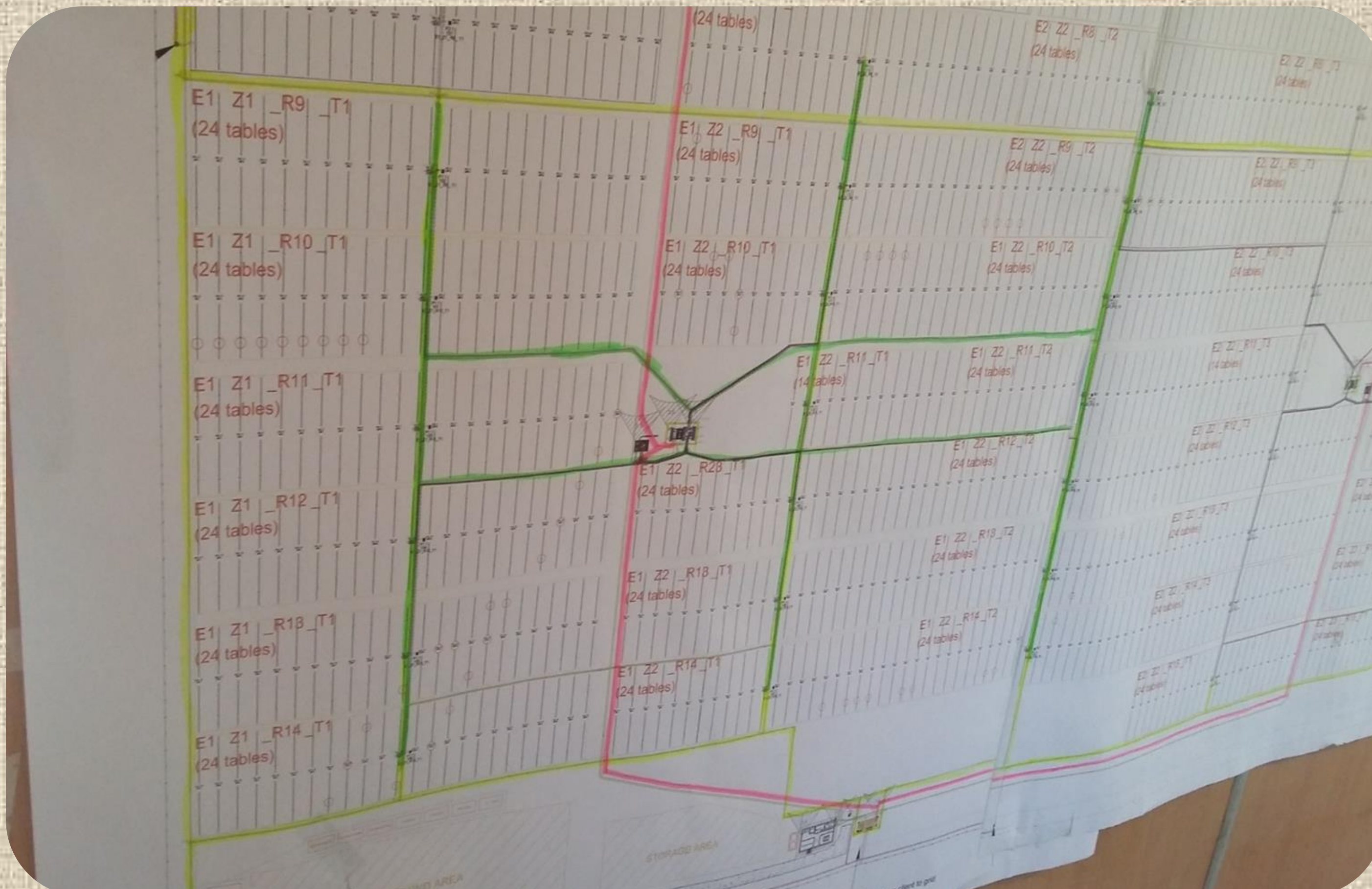
E2 Z2 _R1 _T3
(24 tables)
E2 Z3 _R1 _T1
(24 tables)
EARTHING
MV CABLES
DC CABLES TRENCH
CCTV CABLING
E2 Z2 _R2 _T3
(24 tables)
E2 Z3 _R2 _T1
(24 tables)
E2 Z2 _R3 _T3
(24 tables)
E2 Z3 _R3 _T1
(24 tables)
E2 Z2 _R4 _T3
(14 tables)
E2 Z3 _R4 _T1
(24 tables)
E2 Z2 _R5 _T3
(24 tables)
E2 Z3 _R5 _T1
(24 tables)
E2 Z2 _R6 _T3
(24 tables)
E2 Z3 _R6 _T1
(24 tables)
E2 Z2 _R7 _T3
(24 tables)
E2 Z3 _R7 _T1
(24 tables)

Cabling

Distribution

Cabling

Map



E1 Z1 _R9 _T1
(24 tables)
E1 Z1 _R10 _T1
(24 tables)
E1 Z1 _R11 _T1
(24 tables)
E1 Z1 _R12 _T1
(24 tables)
E1 Z1 _R13 _T1
(24 tables)
E1 Z1 _R14 _T1
(24 tables)
E1 Z2 _R9 _T1
(24 tables)
E1 Z2 _R10 _T1
(24 tables)
E1 Z2 _R13 _T1
(24 tables)
E1 Z2 _R14 _T1
(24 tables)

Grid Connection

Pile

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Motor foundation

Mohammad Parhamfar

MV panel

Test

- Pre-installation Tests
- Tests on Installation
- Tests on commissioning
- Provisional Acceptance Tests
- Annual Tests

Pre-installation Tests

- Dc system inspection
  AC system inspection
- Meteo Station
  Cable laying
- Safty equipment
- Tracking system
- Civil works
- Mechanical connection
- Security system
- Labeling

All equipment installed as specification and design
All system and material necessary for commissioning are ready
All systems and equipment can be operated in a safe manner
All documentation is ready
Reports,certifications and warranties are in place

Test During Manufacture FAT (factory Acceptance Test)

- PV Modules
- Inverters and controller
- Transformer
- HV and MV switchgears

Commissioning

- PV string open test
- PV string U-V Curve
- Polarity test
- Earthing test
- Array insulation test
- IR camera test
- Tracking mechanism test

Compliance with :
IEC 60364-7-712
Design
safty
Proper installation and operation
signs and labeling
Isolation

Inverter test

- Loss of control power
- Loss of array
- Anti islanding
- Maximum power point Tracking(MPP)
- Harmonic Distibution
- Power factor
- Active/Reactive power
- Test of basic network management function(frequency,automatic voltage regulation)

Annual Test

- The test is to verify the PR guaranteed in contract ,for year 1 and year 2 (Performance Ratio)

Formula for manual calculation of the performance ratio	
PR =	$\dfrac{\text{Actual reading of plant output in kWh p.a.}}{\text{Calculated, nominal plant output in kWh p.a.}}$

- Component and design inspection should be carried out:
- String Voltage
- Thermography
- Connections
- Structures
- Foundation

Minimum Requirements

The international standard **IEC 62446** (equivalent to BS EN 62446) **Grid-Connected Photovoltaic Systems—Minimum Requirements for System Documentation, Commissioning Tests and Inspection** sets out the minimum requirements for system documentation and commissioning tests that are required at the start of operation. The following tests are recommended in every facility adhering to this standard

1) Test continuity of equipment grounding conductors and system grounding conductors.
2) Test polarity of all DC cables and check for correct cable identification and connection.
3) Test open-circuit voltage [Voc] for each PV source circuit.
4) Test short-circuit current [Isc] for each PV source circuit.
5) Test functionality of major system components (switchgear, controls, inverters), including inverter anti-islanding.

6) Test insulation resistance of the DC circuit conductors.

Multi-Meter

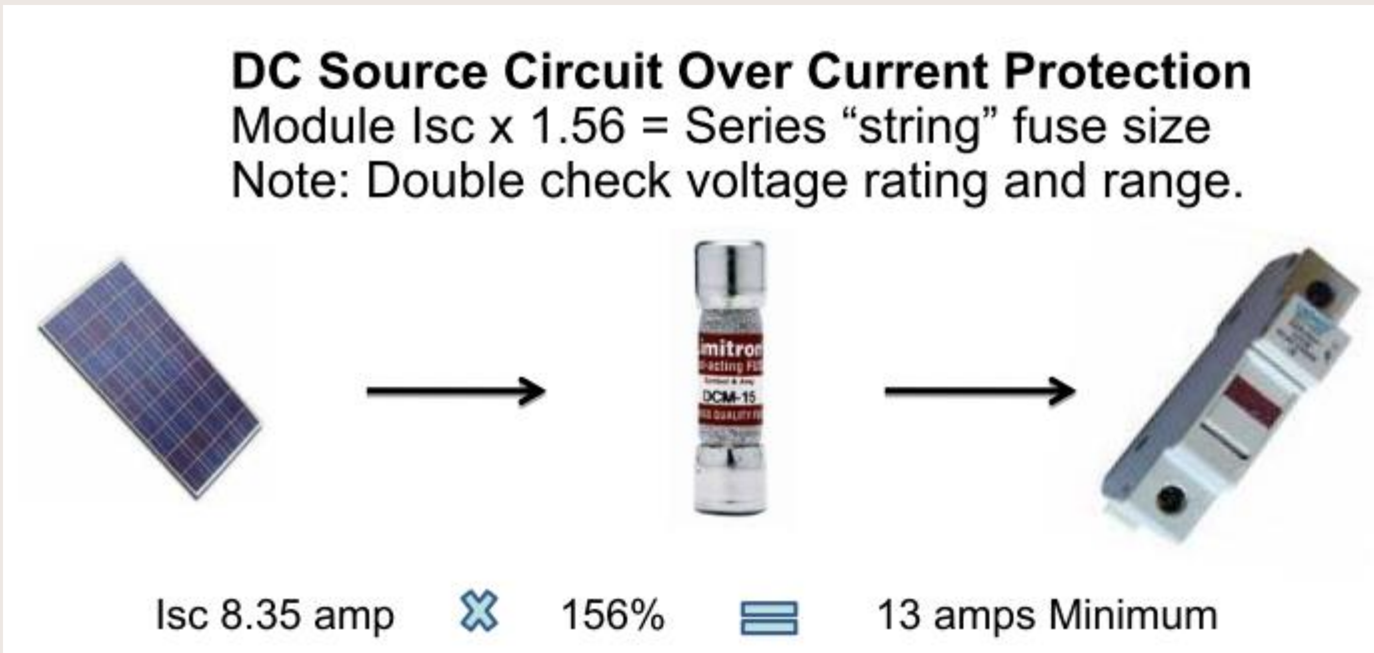
Your multi-meter needs to be rated at 600V minimum and be capable of measuring DC voltage and current.

Inspect Fuses

Open all the circuits in the combiner

- Perform a visual inspection of the fuses make sure they look OK
- Verify that the rating of the fuse corresponds to the rating specified by the module manufacturer.

Inspection


DC Source Circuit Over Current Protection
Module Isc x 1.56 = Series “string” fuse size
Note: Double check voltage rating and range.
DCM-15
Isc 8.35 amp
156%
13 amps Minimum

Polarity and Labels

- Check polarity for all the strings by measuring the voltage differential of the positive end (fused) to negative.
- Also make sure that all strings are properly labeled indicating polarity and string number.

Voc

- Open circuit voltage
    - Voltage reading with muti-meter at combiner
        - Onsite, actual reading
- With your inverter still off and all DC circuits open, measure the voltage between the positive and the negative ends of each string.

Isc

- Amperage maximum power *(operating current)*
  - Reinstall fuses
- Measure the current of every string by clamping your multi-meter around the lead cable.

String Vmp

- Voltage maximum power
  - Reinstall fuses
  - Inverter powered on

Torque Test

- Check torque for all the connections.
- Close all the fused circuits.

Reason to check torque

Invertes

- Inverters
  - Basic information off **nameplate**
    - Manufacturer
    - Model #
    - Serial #
    - kWAC

- *AC Watts*
- *AC VOLTS*

Inverter

- Verify that any calibrations and adjustments for inverters ,Charge Controllers and other equipment are properly set or programmed

Meter

- **Meter**
  - Manufacturer
  - Model
  - Serial Number
  - Meter Register Read kWh

concrete compressive strength

ver: k[[pk West Fence

: Esfahan 10Megawatt solar plant

ınt : metka eng .co

ctor : metka eng . co

tant : -

MINISTRY OF ROAD AND URBAN DEVELOPMENT

TECHNICAL & SOIL MECHANICS LABORATORY .CO

(ostan BRANCH)

Concrete Compressive Strength Results

Test Method : BS EN 12390-3

Job number : ۰۷۰۰۲۴۵۲۲

Type of cement : Type I

Type of sample : Cubic

Specified strength :

Request Number : -

Date : ۲۰۱۴/۱۰/۱۵

g Location : following the north side of the tiny concrete wall

le er	Date of sampling	Slump (cm)	Date of test	Age of Sample	Size of sample(cm)			Cross sectional (cm2)	Volume of sample (cm3)	Weight of sample (gr)	Unit weight (gr/cm3)	Maximum load (Kg)	Corrected load (Kg)	Compressive strength (kg/cm2)
					Height	Width	Length							
)	2016/11/14	9.0	2016/11/21	7	15.0	15.1	15.1	228	3420	8200	2.40	54974	54790	240
)	2016/11/14	9.0	2016/11/21	7	15.1	15.0	15.0	225	3398	8140	2.40	51322	51140	227

Info : Sampling Time :15:50 Concrete Temperature :22 c Environment Temperature :24 c

ption :

nt of field supervisor:

Lab. responsible. sign: محسن سلیمانی فرد

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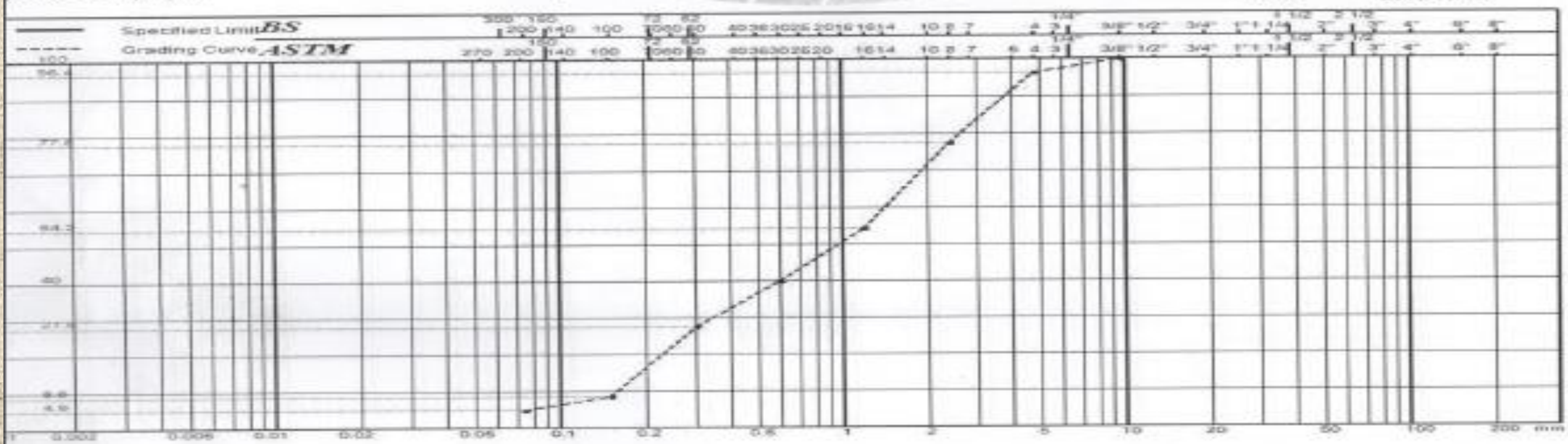
Compaction Test

...sfahan 10Megawatt solar
Location: alghadir mineral
...nt : -
...tion : sand3-0
Date: ۲۰۱۷/۰۱/۱۹

MINISTRY OF ROAD AND URBAN DEVELOPMENT
TECHNICAL & SOIL MECHANICS LABORATORY .CO
(ostan BRANCH)

Report Of Grading and Aggregate Test Results

Employer: Metka Eng . CO
Contractor: metka eng..co
Request Number: -
Date: 2016/10/15



Clay	Silt	Sand	Gravel	Cobble	B.S
Fine (Silt and Clay)		Sand	Gravel	Cobble	Unified

Sampel Number: 14581	Classification: -	Fracture(%) One Face: - Two Face: -	Liquid Limit: غیر قابل تعیین (%)
Lab Number: 070024524	Weight Of Sample: 8770 (gr)	Elongation Index: - (%)	Plasticity Index: N P (%)
Applicant: metka eng-co .	Date Of Report: 2017/01/20	Flakiness Index: - (%)	Sand Equivalent : 55 (%)
			Fines Module : -

Description: alghadir
Comment of field supervisor:
23 JANUARY
Lab. responsible. sign: محسن سلیمانی فرد

Welding Test

Soil Mechanics Laboratory

Subject: Nondestructive test on fence joints

Dear METKA EGN,

Following the METKA EGN's written request dated on Dec 8,2016 about Nondestructive test on fence joints surrounding solar power plant located in Jarghooye, on Dec 9,2016 the Visual Inspection (VI) on joints were done as follow:

- Fence under construction is made of galvanized steel pipe with a diameter of 2 inches (main pipes) and a diameter of 1 inch.
- The defects seen on the joints are unsuitable start/stop point and overlap which shall be removed by grinding and welding. Other joints are acceptable and in suitable position.
- In evaluation of test samples done by the welders, the above mentioned defects were found and in order to remove them the necessary recommendations were given to the welders.
- Welding process is **SAMW**.

Test and Certificates

No	Test
ROAD CONSTRUCTION	
1	Subbase
2	Base
3	Asphalt layer
UNDERGROUND MATERIALS	
4	Clay 1
6	Sand
7	Geotextile For Foundations
8	Waste Management - Soil
OVERGROUND MATERIALS	
9	Curring - Conrete protection
FENCE	
10	Concrete Fence
11	Reinforcement Fence
12	Steel Piles-Columns Fence
13	Mesh and Spiral Fence

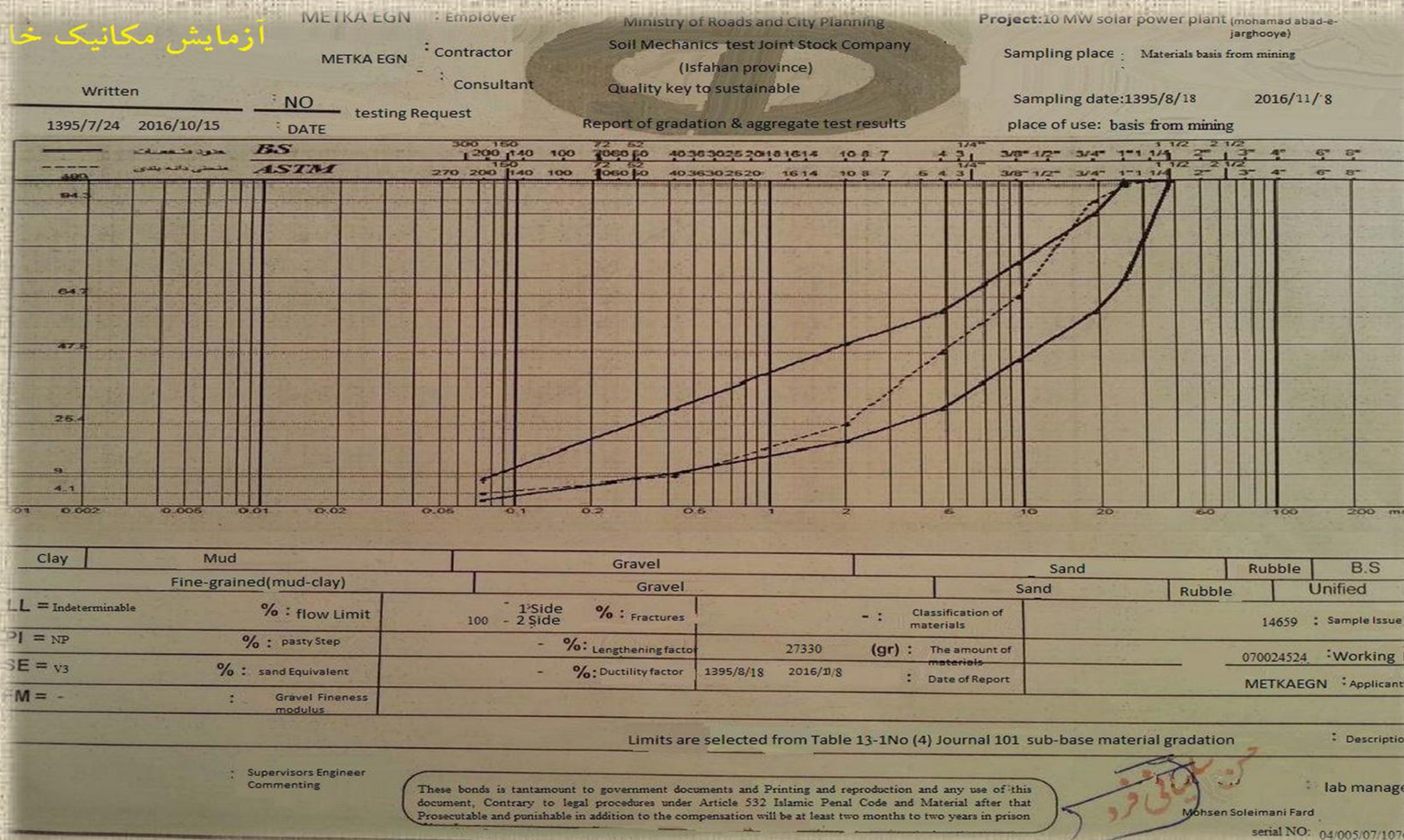
13	Mesh and Spiral Fence
14	Cement Fence
15	Gates Fence- Welding
16	Gate Fence - Material
17	Welding Fence
MVP SUBSTATIONS	
18	Concrete Substations
19	Reinforcement Substations
O&M BUILDING	
20	Concrete O&M Building
21	Civils Installations O&M Building
22	Reinforcement O&M Building

Test and Certificates

23	Electrical Facilities Installation O&M Building
24	RCD Test
25	Mechanical Installation O&M Building
26	Roof Insulation
MAIN SUBSTATION	
27	Concrete Main Substation
28	Reinforcement Main Substation
29	Electrical Installation Main Substation
30	RCD Test
31	Roof Main Substation

30	RCD Test
31	Roof Main Substation
Micromaterials	
32	Production & Distribution Cables
33	Grounding Connections
34	Cable Insulation
35	Cable Terminal Bolts
36	Cable Tire Ups
37	Cable Ditches
38	Materials for Combiner Boxes

Compaction Test



آزمایش مکانیک خا

METKA EGN : Employer
METKA EGN : Contractor
- : Consultant

Ministry of Roads and City Planning
Soil Mechanics test Joint Stock Company
(Isfahan province)
Quality key to sustainable

Project:10 MW solar power plant (mohamad abad-e-jarghooye)
Sampling place : Materials basis from mining
Sampling date:1395/8/18 2016/11/8
place of use: basis from mining

Written
NO
1395/7/24 2016/10/15 DATE
testing Request

Report of gradation & aggregate test results

Clay	Mud	Gravel	Sand	Rubble	B.S
Fine-grained(mud-clay)		Gravel	Sand	Rubble	Unified

LL = Indeterminable	% : flow Limit	100 - 1 Side / 2 Side	% : Fractures	- : Classification of materials	14659 : Sample Issue
PI = NP	% : pasty Step	-	%: Lengthening factor	27330 (gr) : The amount of materials	070024524 :Working N
SE = V3	% : sand Equivalent	-	%: Ductility factor	1395/8/18 2016/11/8 : Date of Report	METKAEGN : Applicant
FM = -	: Gravel Fineness modulus				

Limits are selected from Table 13-1No (4) Journal 101 sub-base material gradation : Description

: Supervisors Engineer Commenting

These bonds is tantamount to government documents and Printing and reproduction and any use of this document, Contrary to legal procedures under Article 532 Islamic Penal Code and Material after that Prosecutable and punishable in addition to the compensation will be at least two months to two years in prison

: lab manager
Mohsen Soleimani Fard
serial NO: 04/005/07/1076

Logistic on Site

RECEIVING

UNLOADING

STORAGE

Pre assemby

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Dispatching

RECEIVING

It is compulsory for the person in charge of receiving the goods delivered to check the conformity before signing the delivery note. Any irregularities regarding the delivery (damage, missing product, and damaged packaging) must be substantiated in a written report, and accurately described in the various delivery documents (waybill, delivery note...) in the presence of the driver.

MAIN STEPS

- Monitor the unloading of goods from trucks, or the emptying of containers.

- If this falls under your responsibility, use telescopic forklifts, cranes, platforms and other appropriate handling equipment to unload and store the goods.

- Check delivery documents, ensure the compliance of the goods received, report the missing quantities, monitor the condition of goods and make comments on the documents if and when necessary.

- Supervise the storage of goods on dedicated storage areas.

Unloading

Use appropriate equipment to handle the load: liftgate, forklift, slings, telescopic forklift, unloading platform, crane to unload the Open Top containers ...

Storage

Consolidate all deliveries in an appropriate and dedicated area

Storage

The goods will be unloaded and stored by type of parts, organized in columns to facilitate the identification of parts

Storage

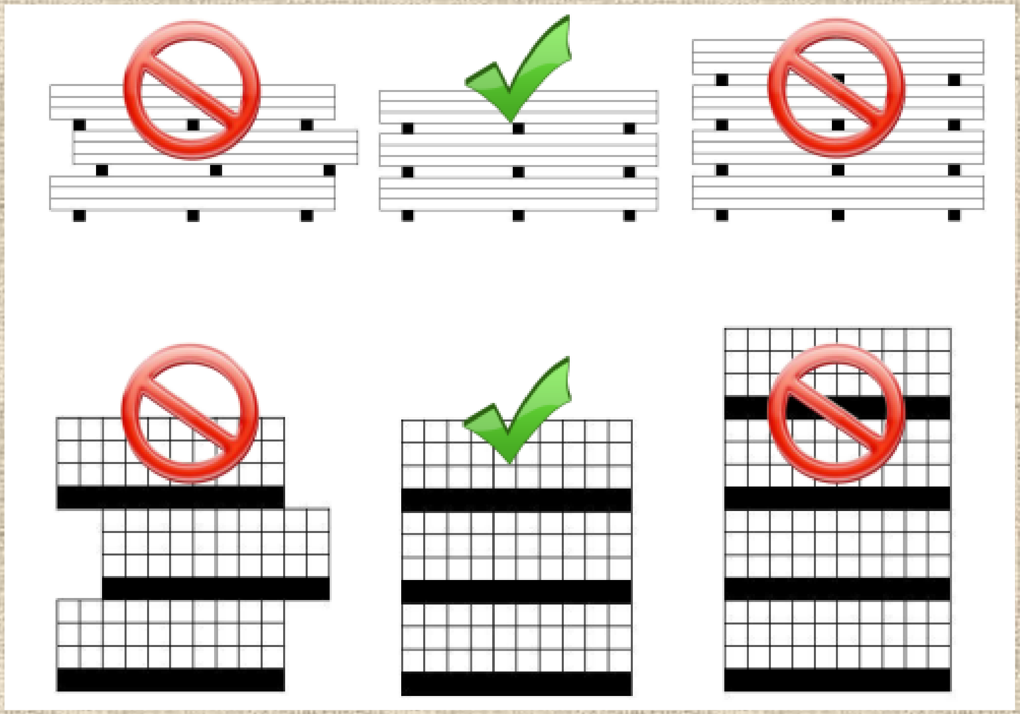
 Small and sensitive components must be placed in containers or in a store: Nuts & bolts, anemometer, inverter, T-bushing, DTU, flange, emergency stop box ...
 Install or create shelves to maximize space and storage.

Storage

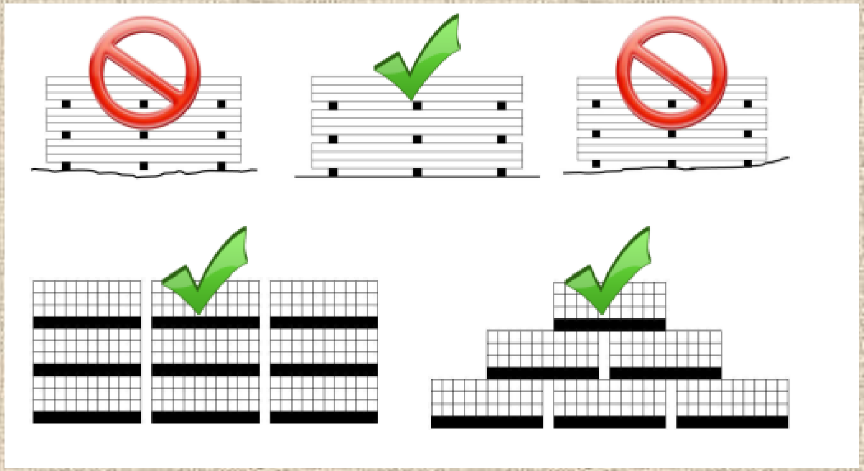
- Spread the load: light parts on top (washer, anemometer), medium in the middle (nut, T-bushing), heavy and bulky parts at the bottom (screw, clamp).

Storage

The bundles of piles or girders must be stored on a flat surface to ensure integrity and stability. Here are some tips for storage.



Storage



Storage

Pre assemby

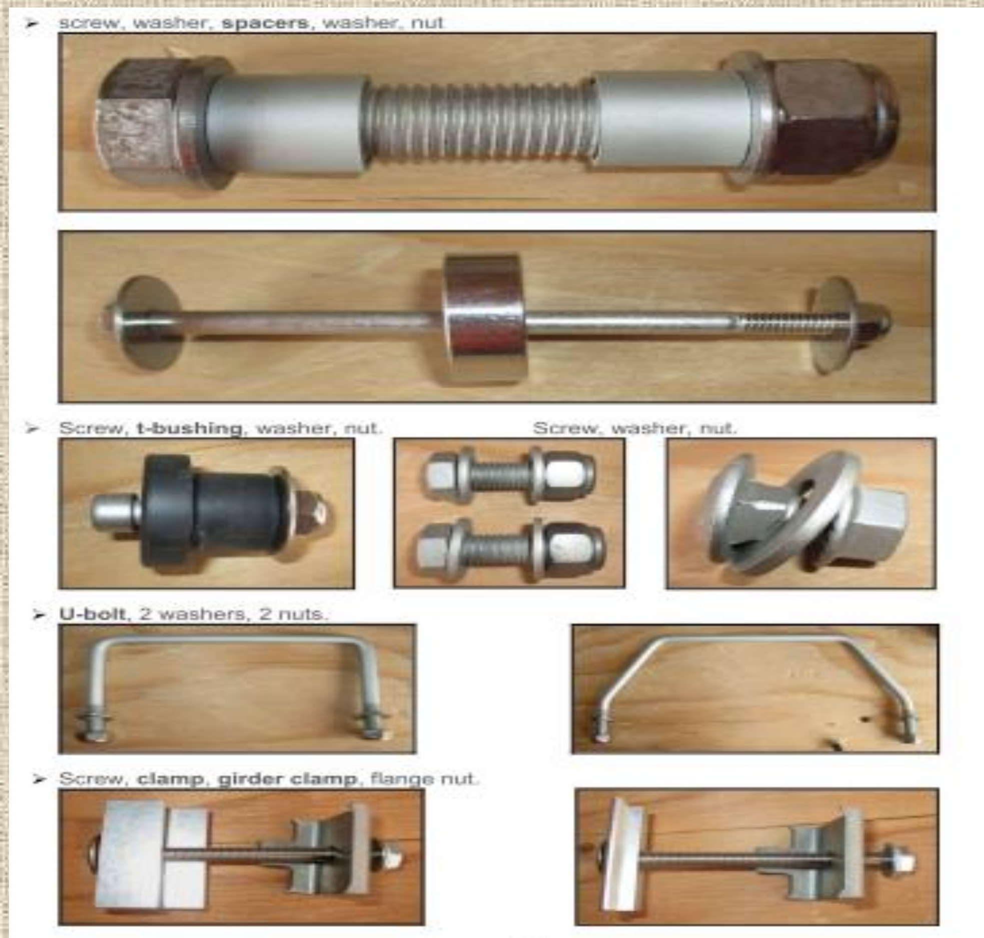
- It is highly recommended to pre-mount hardware.

Your advantages :

- Save time for dispatch and assembly.
- Avoid losing small parts on the ground.
- Test parts and put aside non-conformities (NC).

متخصصین برق ایران

Pre assemby



Pre assemby

Dispatch

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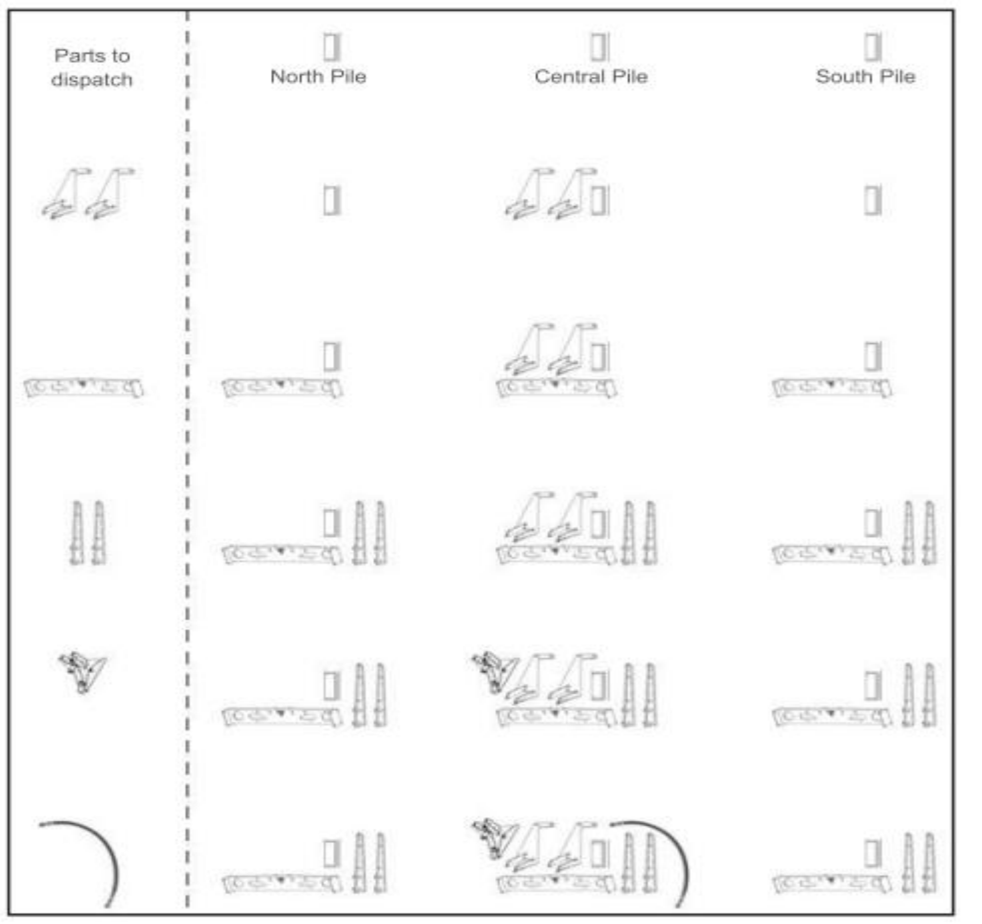
Dispatch

Dispatch

- ✓ Arch assy
- ✓ Rocking units
- ✓ Axle supports
- ✓ Daily tracking units (DTU)
- ✓ Arches



Payment schedule

Advanced Payment	10 %
100%Fence /Civil work completed	25%
50% of Mounting Structure Installed	32.5%
100% of Mounting Structure Installed	40%
50% of Modules Installed	55%
100% of Modules Installed	70%
100% of inverters installed	85%
Electromechanical Completion	90%
Provisional Acceptance	100%

نیروکده

متخصصین برق ایران

Mohammad Parhamfar

Tel: +989132252314

Email : En.parhamfar@gmail.com

Telegram Id :@parhamfar1364

Instagram : Parhamfar

Site:www.7ec.ir