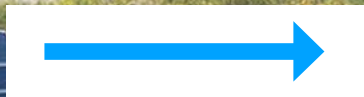


Construction Operation Guide for Industrial and Commercial Distributed Roof Photovoltaic Power Stations





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Preparation for pre construction work and safety protection requirements

Materials to be prepared before project construction operations:

- Preliminary design drawings approved by the design institute for project drawings;
- Roof bearing capacity report; Approval of the power supply bureau's access system scheme.

Conditions required on site before project construction operations:

- Construction site water, electricity, access roads, and site leveling (three connections and one leveling).
- "Five signs and one map" should be set up on the construction site, and the on-site fence should meet relevant requirements.

Requirements for personal safety protection:

- Before entering the venue, correctly wear the uniformly issued safety helmet, reflective vest, and protective measures such as safety shoes.

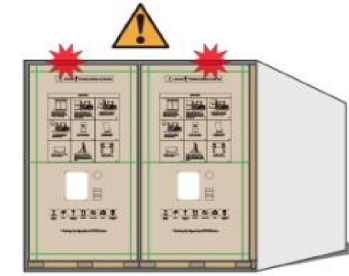
Requirements for edge protection:

- Before starting the roof work, observe whether there is a parapet wall on the roof, whether the height of the parapet wall reaches 1.2 meters, and whether there is a lighting strip. If there is no protection on the edge and there is a lighting strip, it is necessary to set up edge protection railings and lay white anti fall nets on the lighting strip.

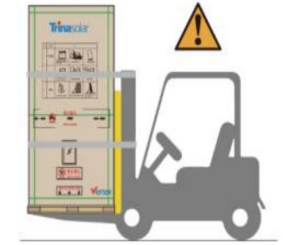


Guidelines for photovoltaic module construction operations

- Confirm the quantity and model specifications of the components upon arrival to ensure they are consistent with the bill of lading;
- Check the outer packaging of the components for any deformation, collision, damage, or scratches;
- Collect product qualification certificates, factory inspection reports, and keep good records of unpacking;
- When unloading modules, special attention should be paid to being "slow" and "stable". After unloading modules, they should be placed on a flat and solid ground, strictly prohibited from tilting or tipping, and the placement area of photovoltaic modules should not affect traffic roads;
- When lifting, the entire pallet should be lifted, and it is strictly prohibited to lift loose and unfastened components. The lifting and lowering process should be smooth and slow, without significant shaking, to prevent component damage;
- It is strictly prohibited to stack components in a centralized manner after lifting them to the roof. Components should be placed and fixed in a scattered manner;
- Single person handling of photovoltaic modules is strictly prohibited. It must be carried by two people and handled with care;
- Avoid large vibrations on the components to prevent hidden cracks in the photovoltaic modules;
- The unboxed components on the construction site need to be placed flat with the front facing upwards;
- The MC4 connector of the component connection line is not installed and should be covered with transparent tape.



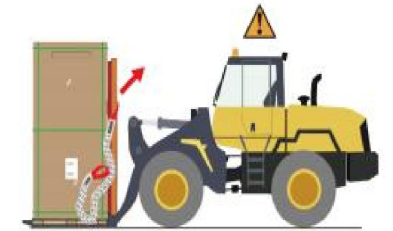
Preventing top collision in imported containers



It is recommended to use a safety rope to secure the components to the forklift, keep them upright during transportation, and prohibit personnel from standing on both sides



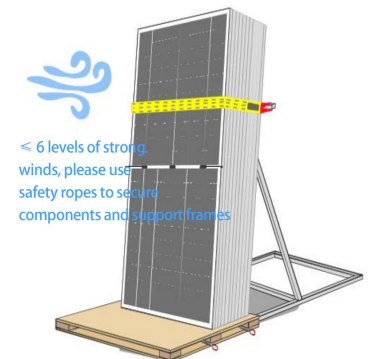
Please control the speed to prevent tipping



Place the packaging box steadily on the ground (No risk of tipping)
Unfasten the safety rope again



When transporting by truck, the packaging box must be tilted against the forklift gantry and the components must be fixed to the forklift with a safety rope with a tensile strength of >2000kgf, and the speed must be controlled to prevent tipping.



≤ 6 levels of strong winds, please use safety ropes to secure components and support frames

Guidelines for photovoltaic bracket construction work

- Component installation flatness: The height difference between the edges of the phase components shall not exceed 2mm;
- The connectors between components should be firmly plugged in, and before connecting the connectors, they should be kept dry and clean;
- It is strictly prohibited to step on components and scratch the front glass and back panel;
- It is strictly prohibited to touch the metal charged parts of the photovoltaic string, and it is strictly prohibited to connect photovoltaic modules in the rain;
- The components are installed firmly without any looseness or slipping, and the component pressure blocks have no flash joints. The U-shaped steel inner plastic wing nut rotates to 90 ° with the guide rail;
- The small wires and MC4 joints of the color steel tile roof components must be hung with metal ties with insulation skin and cannot come into contact with the roof;
- Each string number (hang tag or number tube) of the component should be clearly marked in a prominent position and correspond to the drawing for easy operation and maintenance;
- The width of the reserved operation and maintenance channel for each square array is generally required to be 250cm. The distance between the component frame and the edge of the daylighting strip should not be less than 100mm; The main maintenance channel should be able to reach the position of each string inverter, and the width of the main maintenance channel is generally required to be 250cm;
- Component installation inclination angle and azimuth angle installation inclination angle and design error within ± 2 ;
- The spacing between fixtures along the guide rail direction is ≤ 1 m.



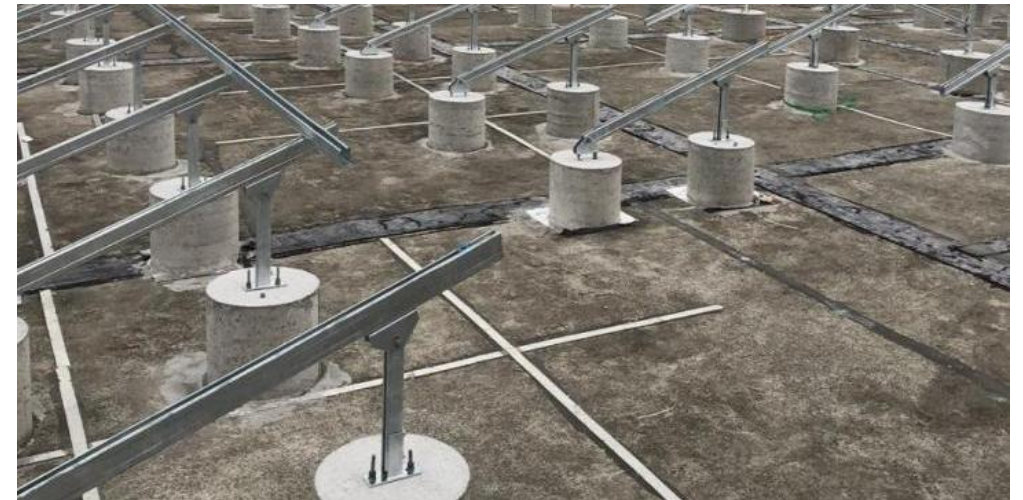
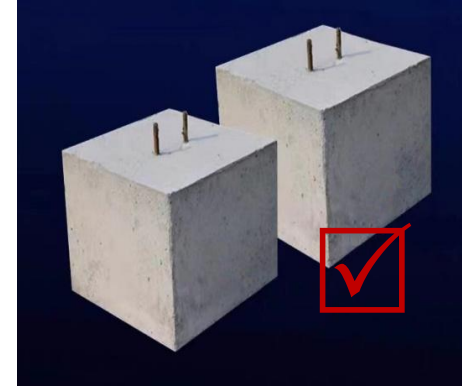
Guidelines for photovoltaic bracket construction work (concrete roof)

- Support installation: When connecting the support, it should be ensured that the connection parts are tightly connected, the installation surface of the components is horizontal, and there is no distortion or uneven height. All connection points in the support groove should be fastened with galvanized hexagonal bolts or formula shaped nuts and plastic buckles; Each bolt is equipped with a flat spring washer, and the connection points outside the groove are fastened with galvanized hexagonal bolts. Each bolt is equipped with a flat spring washer;
- Column support installation: When fixing the column support to the counterweight block, the dust in the screw holes should be blown clean, and the end plate should be horizontally aligned with the counterweight. If the support or counterweight surface is uneven, an iron plate or other tools should be used for leveling. At least one spring washer should be used for the expansion bolt, and the nut should be tightened to expose 2-3 threads;
- Rail splicing: If the length of a single piece does not meet the requirements, rail splicing can be carried out. Align and slide the two guide rails along the connecting slots of the guide rails, adjust their positions to align the bolt holes, and then lock them with four matching hexagonal bolts



Guidelines for photovoltaic bracket construction work (concrete roof)

- Prefabricated concrete counterweight blocks: consistent in size and specifications; Concrete strength above C25; Quality issues such as smooth surface, smooth appearance, no leakage of reinforcement, honeycomb, holes, inclusions, looseness, cracks, external or surface defects are required. The strength of the cast-in-place cement counterweight should reach 70% or more of the design strength;
- Cast in place concrete counterweight block: It should be accurately positioned, and the bottom of the counterweight block should be chiseled and treated in advance. The curing time should be more than 7 days, and other requirements should be the same as those of prefabricated concrete counterweight blocks;
- Cement pier layout: According to the design drawings and construction requirements, measure and lay out the cement piers using ink buckets and wire ropes, and confirm the distance and quantity in the front, back, left, and right directions of the cement piers.



Photovoltaic bracket construction operation guide (color steel tile roof)

- Installation of Color Steel Tile Fixture: Used for the installation of clips that match the color steel corrugated tiles. The screw connection should be two flat and one spring should not be missing. The bolt should be tightened until the spring pad is pressed flat. After the clip is installed, use a pull-out force tester to measure whether the clip is securely installed. The pull-out force should be greater than 1000N, and the coastal area should be appropriately increased according to local wind pressure calculation standards;
- Installation of color steel tile guide rail: Each fixture must be connected to the guide rail with bolts, and guide rail connectors must be used for docking between the guide rails. Welding is prohibited. The installation of guide rail connectors must tighten 4 bolts.



Guidelines for Construction of Photovoltaic Inverters

- Confirm whether the quantity and specifications of the inverter upon arrival are consistent with the bill of lading. Check if the inverter is outsourced;
- Equipped with no deformation, scratches, and whether the paint is intact. Collect product qualification certificates and factory inspections;
- Report and keep a good record of unpacking. If any problems are found, take photos and evidence in a timely manner;
- The inverter inlet connector should be firmly connected and kept dry and clean before connecting the connector;
- During the installation or debugging process, once the inverter starts, it needs to be powered off and wait for at least 5 minutes until the internal components are fully discharged before replacing the connectors and other operations can be carried out;
- The inverter and photovoltaic grounding ring network need to be connected with a dedicated yellow green grounding wire, and the connection point must be reliable;
- (The resistance is generally less than 4 Ω) The grounding of the casing should be reliable, and the wiring terminals should be crimped;
- The inverter is not using an interface and is covered with a dedicated protective cover.



Guidelines for Construction of Photovoltaic Inverters

- The bridge should be laid below the inverter;
- Each DC terminal of the inverter must be equipped with a number tube that corresponds to the connected group in series, and should be connected in series;
- Measure the positive and negative poles and open circuit voltage;
- Components with different slope orientations are not allowed to connect to the same string;
- Strings with different slope directions are not allowed to be connected to the same MPPT of the same inverter;
- Leave more than 60cm of space on the left and right sides of the inverter, 20cm of space on the upper part, and 45cm of space on the lower part. There should be no obstacles within 1m in front, and ventilation should be maintained around;
- When installing inverters outdoors, the top should be well shaded and rainproof;
- Post a label on the inverter, with dimensions of 20cm in width and 15cm in height. Material and specifications: 1.0mm thick stainless steel painted label, with reference to design requirements for numbering.



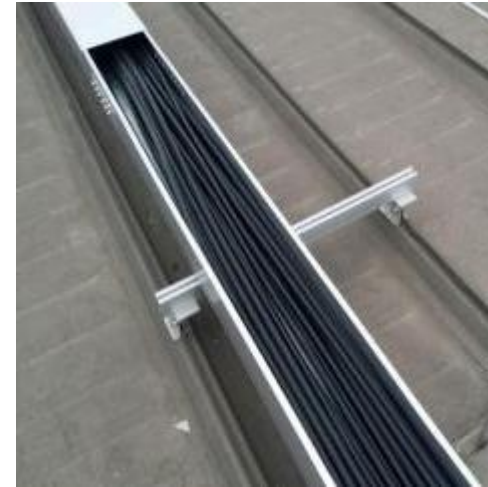
Cable laying and cable tray construction operation guidance

- The outside of the bridge must be flat and smooth, without scratches, and there should be no sharp edges, burrs, or damaged exposed parts of the cable insulation inside;
- The bridge cover plate is fixed with buckles, and the cover plate is fixed completely without any problems such as warping or deformation. After fixing, tie the bridge cover plate with stainless steel straps on both sides;
- The bridge system should have reliable electrical connections and grounding. There must be a clear grounding point every 25 meters, and the grounding resistance at the joints should not exceed 4Ω ;
- The cable tray should be suspended from the roof, with a height of no less than 5cm from the roof, without direct contact, and ensure that it is firm and reliable, without significant swinging. The bottom of the bridge has drainage function;
- The large cables inside the vertical cable tray (offline cable tray) should be fixed and tied with round steel at least 2 meters apart, and the cable protection work should be done well;
- Rubber must be placed at the corners of vertical cable trays;
- The installation position of vertical cable trays must be approved and confirmed by the owner to ensure aesthetic and neat appearance;
- Fasteners (such as screws, nuts, etc.) are required to be made of 304 stainless steel material. The connection position of the hot-dip galvanized bridge should be connected to the grounding wire, and cables entering and exiting the bridge should be protected by cable glands;
- AC and DC cables should be laid separately. When communication cables and power cables are laid on the same tray, they should be placed on both sides of the partition board;
- The spacing requirement for bridge support is $\leq 2.5\text{m}$



Cable laying and cable tray construction operation guidance

- Armored cables should be selected for cables drawn from the roof and ground. For cables that need to be laid in a broken path, galvanized steel pipes should be used as protective sleeves;
- The cables on the roof cannot be exposed and need to be laid through cable trays. The string cables need to have protective pipes, and PE pipes can be used. The protective sleeves should be fixed and not subjected to force or bending;
- The two ends of photovoltaic dedicated cables should be connected using photovoltaic dedicated connectors;
- Photovoltaic dedicated cables need to be color separated (red positive and black negative). Both ends of each section of electricity need to be hung up and labeled.



Cable laying and cable tray construction operation guidance

Cable tagging:

- The cable license plate is made of PVC material and double-sided plastic sealing;
- Cable license plate size: width 30mm, length 70mm, thickness 1mm;
- The specific content on the cable license plate: (from top to bottom, from left to right) Starting point, ending point, specifications, font size: Song typeface, small four, bold;
- The cable license plate is punched at both corners and tied with dedicated tie wires;
- Cable license plates shall be printed uniformly using a hot stamping machine and shall not be handwritten. All license plates shall be marked completely and printed clearly to the outside;
- The string number indicates the north-south slope or east-west slope, which is convenient for later operation and maintenance.



Cable number tube:

- The wire core printing sleeve is made of PVC material;
- Sleeve model: The selected inner diameter should match the cable diameter, the sleeve length is specified as 40mm, and the color should be white;
- Content of wire core sleeve printing number: Design the given number, font size: Song typeface, size five, bold, The wire core sleeve is printed using a dedicated marking machine, and handwriting is strictly prohibited. It is required to have clear markings and full printing. Installed at the wiring point, with one side of the font uniformly facing outward and the font direction uniformly facing left;
- MC4 male and female connectors or photovoltaic cables used on the same project must be from the same manufacturer.



Construction operation guidance for electrical equipment such as grid connected cabinets

- Basic tools and safety tools should be equipped in the distribution room. Safety tools include but are not limited to insulated gloves, insulated boots, electric testing rods, and grounding wires. Tools should be placed in the tool cabinet;
- Safety protective equipment must have an inspection certificate and be guaranteed to be within the validity period of the inspection;
- If the grid connected cabinet shares the distribution room with the owner, safety warning lines should be marked around the grid connected cabinet;
- At least 2 fire extinguishers should be equipped for fire safety and placed in dedicated fire extinguishers. Regular inspection signs should be hung on the fire extinguishers;
- Qualified and suitable insulation pads must be laid before and after the switchgear;
- Fixed numbers and corresponding safety signs should be installed on the outer side of the box transformer;
- The AC busbar of the grid connected cabinet should be insulated with heat shrink tubing, and the insulation spacing should meet the national standard;
- There should be standardized safety regulations on the wall in independent distribution rooms;
- Requirements for safety distance of different voltage levels.



Construction operation guidance for lightning protection and grounding engineering

Roof exposed grounding ring network

- The roof grounding ring network can be connected by hydraulic punching method and overlapped with bolts at no less than two places, and 90 degree grounding elbows must be used at cross, T-shaped, and right angle connections;
- The lightning protection level of the photovoltaic system cannot be lower than that of the original building;
- The connection points between the lightning protection strip and the building body should be symmetrically arranged, with no less than 2 points. The distance between the perimeter of the third level lightning protection building should not be 25m, and the distance between the perimeter of the second level lightning protection building should not exceed 18m. And when connecting to the building body, it should also be connected to the fence;
- The principle of "+block board". The component frame should be connected to each other using BVR yellow green cables or grounding pads with a cross-sectional area of no less than 4mm², and directly connected to the grounding flat iron (indirect connection through aluminum alloy rails, etc. is not allowed). Any flat iron directly connected to the grounding point from the frame of a battery module cannot pass through 10 battery panels;
- The grounding flat iron can be fixed using component rails or fixtures, and cannot be placed directly on the roof or on the ground;
- The grounding wire should be firmly fixed, installed flat and straight. The roof grounding should not be painted with yellow and green color codes, and the bolt connection overlap should not be painted;



Construction operation guidance for lightning protection and grounding engineering

Inverter grounding

- The grounding wire (tin coated) of the inverter should be connected to the grounding ring using a 16mm² yellow green wire, and the length of the grounding wire (tin coated) should not exceed 50cm. Otherwise, a flat iron should be used to connect the inverter bracket to the grounding ring network using bolts;
- A crossbar should be installed at the point where the grounding flat iron crosses the ridge, with a certain degree of curvature and beautiful craftsmanship requirements;
- Roof video monitoring and environmental detection grounding:
- Roof video monitoring and environmental detection should use grounding flat iron to reliably connect to the main grounding network. The grounding wire should be fixed with bolts.



Cable tray section grounding

Cable tagging:

- When the total length of the cable tray is not more than 30m, it should be connected to the grounding grid at least 2 times;
- When the total length is greater than 30m, connection points with the grounding grid should be added every 20m to 30m;
- The starting and ending ends of cable trays should be reliably connected to the grounding grid;
- The two ends of the connecting plate between cable trays should be crossed with yellow green copper core grounding wires, with a minimum cross-sectional area of not less than 4mm². They should be connected on the side of the cable tray and should not be fixed on the bolts of the connecting plate;



Equipment shell grounding (primary and secondary prefabricated compartment SVG, type transformer, centralized inverter, etc.):

- The grounding wires of similar equipment are in the same position and direction, and the exposed parts are painted with yellow and green color codes. The spacing width of the color codes is consistent, and the top layer is yellow;
- The curvature of the grounding wire is naturally curved and the process is aesthetically pleasing;
- The equipment grounding adopts bolt connection, with no less than two grounding points. The bolt connection contact surface is tight, the connection is firm, the exposed length of the bolt thread is consistent, and the accessories are complete.

