MANIREDA's GUIDELINEs FOR GRID CONNECTED ROOFTOP SOLAR POWER PLANT

The Technical Specifications and Dos' & Don'ts of the Grid Interactive Rooftop Solar Power Plant read with Section-II of the MANIREDA's Expression of Interest EOI No.4/SPP/RT/MANIREDA/2017-18 dt.19/8/2017 based on MNRE's Operational Guidelines No.5/22/2013-14/RT dtd.18.09.2015 as elaborated & clarified for application as follows:

General Technical specifications

1. SPV Modules

- Indigenously manufactured PV modules should be used.
- The PV module should have crystalline silicon solar cells and must have a certificate of testing conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory.
- The power output of the module(s) under STC should be a minimum of 100 Wp at a load voltage* of 16.4 ± 0.2 V. V_{nom} 12V.
- The open circuit voltage* of the PV modules under STC should be at least 21.0 Volts.
- The module efficiency should not be less than 14 %.
- The terminal box on the module should have provision for opening to replace the cable, if required.
- PV modules must be warranted for their output peak watt capacity which should not be less than 90 % at the end of 10 years and 80% at the end of 25 years.
- **Identification and Traceability**

➢ Each PV module used in any solar power project must use a RF identification tag. The following information must be mentioned in the RFID used on each module (This should be inside the laminate and must be able to withstand harsh environmental conditions.)

➢ Name of the Manufacturer of PV module

➢ Name of the manufacturer of Solar Cells.

➢ Month and year of the manufacture (separately for solar cells and module).

➢ Country of origin (separately for solar cells and module).

➢ I-V curve for the module.

➢ Peak wattage, Im ,Vm and FF for the module.

➢ Unique serial no and model no of the module.

- Date and year of obtaining IEC PV module qualification certificate.
- Name of test lab issuing IEC certificate
- Other relevant information on traceability of solar cells and module as per ISO 9000 series.

2. ARRAY STRUCTURE :-

- Hot dip galvanized MS mounting structures may be used for mounting the modules /panels/arrays. Minimum thickness of galvanization should be at least 120 microns.
- Each structure should have angle of inclination as per the site conditions to take maximum insolation. However to accommodate more capacity the angle inclination may be reduced until the plant meets the specified performance ratio requirements.
- The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed (wind speed of 150 kM/ hour). It may be ensured that in case of capacity above 10kWp, the design has been certified by a recognized Lab/ Institution in this regard and submit wind loading calculation sheet to MANIREDA.
- Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed.
- The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.
- Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.
- Aluminium structures also can be used which can withstand the wind speed of respective wind zone. Necessary protection towards rusting need to be provided either by coating or anodization.
- The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.
- Regarding civil structures the EoI holder need to take care of the load bearing capacity of the roof and need arrange suitable structures based on the quality of roof.
- The total load of the structure (when installed with PV modules) on the terrace should be less than 60 kg/m2 . The minimum clearance of the structure from the roof level should be 300 mm.

Solar Array Fuse : The cables from the array strings to the solar grid inverters shall be provided with DC fuse protection. Fuses shall have a voltage rating and current rating as

required. The fuse shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

Detailed specifications for the mounting structure:

Wind velocity withstanding capacity	150 km / hour
Structure material	Hot dip galvanised steel with a minimum galvanisation thickness of 120 microns or aluminium alloy.
Bolts, nuts, fasteners, panel mounting clamps	Stainless steel SS 304
Mounting arrangement for RCC-flat roofs	With removable concrete ballast made of pre-fabricated PCC (1:2:4), M15
Mounting arrangement for metal sheet roofs	Mounting directly on the sheet metal, ensuring stability and wind withstanding capacity, or penetrating the sheet metal and fixing to the substructure, ensuring that the roof remains water proof and ensuring stability and wind withstanding capacity
Mounting arrangement for elevated structures	The elevated structure has to be securely anchored to the supporting surface. Concrete foundations of appropriate weight and depth for elevated structures mounted directly on the ground; Bolted with anchor bolts of appropriate strength for elevated structures mounted on RCC surfaces.
Mounting arrangement for ground installations	With removable concrete ballast made of pre-fabricated PCC (1:2:4), M15; assuring enough ground clearance to prevent damage of the module through water, animals and other environmental factors.
Installation	The structures shall be designed for simple mechanical on-site installation. There shall be no requirement of welding or complex machinery at the installation site.
Minimum distance between roof edge and mounting structure	0.6m
Access for panel cleaning and maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.
Panel tilt angle	North – south orientation with a fixed tilt angle of 22 – 24degrees (depending on

	location), south facing.

3. **JUNCTION BOXES (JBs)** :-

- The junction boxes are to be provided in the PV array for termination of connecting cables. The J. Boxes (JBs) shall be made of GRP / FRP / Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement. All wires / cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.
- Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single / double compression cable glands. Provision of earthings. It should be placed at 5 feet height or above for ease of accessibility.
- Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups.
- Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.
- All fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

4. DC Combiner Box :

A DC Combiner Box shall be used to combine the DC cables of the solar module arrays with DC fuse protection for the outgoing DC cable(s) to the DC Distribution Box.

5. DC DISTRIBUTION BOARD/BOX :-

- The DC Distribution panel/box is to receive the DC output from the array field. The DC distribution box shall be mounted close to the solar grid inverter. The DC distribution box shall be of the thermo-plastic IP65 DIN-rail mounting type and shall comprise the following components and cable terminations: − Incoming positive and negative DC cables from the DC Combiner Box; − DC circuit breaker, 2 pole (the cables from the DC Combiner Box will be connected to this circuit breaker on the incoming side); − DC surge protection device (SPD), class 2 as per IEC 60364-5-53; − Outgoing positive and negative DC cables to the solar grid inverter.
- As an alternative to the DC circuit breaker a DC isolator may be used inside the DC Distribution Box or in a separate external thermoplastic IP 65 enclosure adjacent to the DC Distribution Box. If a DC isolator is used instead of a DC circuit breaker, a DC fuse shall be

installed inside the DC Distribution Box to protect the DC cable that runs from the DC Distribution Box to the Solar Grid Inverter.

- The bus bars are made of copper of desired size. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

6. PCU / ARRAY SIZE RATIO :-

• The combined wattage of all inverters should not be less than rated capacity of power plant under STC.

• Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

7. Power Conditioning Unit (PCU)

The **PCU** should convert DC power produced by SPV modules, into AC power and adjust the voltage & frequency levels to suit the local grid conditions. The inverter shall interconnect and feed power to the LT power supply of the building and also shall have the provision to power critical loads.

Common Technical Specification :

- Control Type : Voltage source, microprocessor assisted , output regulation
- Output voltage : Single Phase, 230 V ac (+12.5 %, - 20 % V ac)
    - : 3 phase, 415 V ac (+12.5 %, - 20 % V ac)
- Frequency: 50 Hz (+3 Hz, -3 Hz)
- Total Harmonic Distortion : less than 3%
- Operating temperature Range : 0 to 55 deg C

Inverter standards :

Inverter should comply with IEC 61683/IS 61683 for efficiency and Measurements and should comply IEC 60068-2 (1, 2, 14, 30) / Equivalent BIS Standard for environmental testing. Inverter should supervise the grid condition continuously and in the event of grid failure (or) under voltage (or) over voltage, Solar System should be disconnected by the circuit Breaker / Auto switch provided in the inverter.

Power Control : MPPT

Other important Features/Protections required in the INVERTER:

- Automatic morning wake-up and nightly shutdown
- Mains (Grid) over-under voltage and frequency protection
- Fool proof protection against ISLANDING.
- Included authentic tracking of the solar array's maximum power operation voltage (MPPT).
- Array ground fault detection.
- LCD and piezoelectric keypad operator interface Menu driven
- Automatic fault conditions reset for all parameters like voltage, frequency and/or black out.
- Surge arresters on AC and DC terminals for over voltage protection from lightning-induced surges.
- INVERTER should be rated to operate at 0 –55 deg. Centigrade unless provision for air conditioning is included in INVERTER
- All parameters should be accessible through an industry standard communication link.
- Overload capacity (for 10 sec) should be 150 % of continuous rating
- Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) but in case of less than 10kW single phase inverter can be used.
- The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.
- **Anti-islanding (Protection against Islanding of grid):**
  The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.
  a. Channel Partner shall be responsible for galvanic isolation of solar roof top power plant (>100kW) with electrical grid or LT panel.
  b. In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a **separate Isolation Transformer** of suitable rating provided at the output side of PCU/PCU units for capacity **more than 100 kW**.
- The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14, 30)/ Equivalent BIS std.

Harmonics Standard :

As per the standard of IEEE 519, the permissible individual harmonics level shall be less than 3% (for both voltage and current harmonics) and Total Harmonics Distortion (THD) for both voltage and current harmonics of the system shall be less than 5%.

8. AC DISTRIBUTION BOX/ BOARD :-

- An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of the thermo plastic IP65 DIN rail mounting type and shall comprise the following components and cable terminations:

  − Incoming 3-core / 5-core (single-phase/three-phase) cable from the solar grid inverter − AC circuit breaker, 2-pole / 4-pole − AC Surge Protection Device (SPD), class 2 as per IEC 60364-5-53 − Outgoing cable to the building electrical distribution board.

- AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter, and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode.
- All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS 60947 part I, II and III.
- The changeover switches, cabling work should be undertaken by the EoI holder as part of the project.
- All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz. The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.
- All indoor panels will have protection of IP54 or better. All outdoor panels will have protection of IP65 or better.
- Should conform to Indian Electricity Act and rules (till last amendment).
- All the 415 AC or 230 volts devices / equipment like bus support insulators, circuit breakers, SPDs, VTs etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions Variation in supply voltage +/- 10 % Variation in supply frequency +/- 3 Hz.

Technical and interconnection requirements

Overall conditions of service	**State Distribution/Supply Code**
Overall Grid Standards	Central Electricity Authority (Grid Standard) Regulations 2010

Equipment	BIS / IEC / IEEE
Meters	Central Electricity authority (Installation & operation of meters) Regulation 2006 as amended time to time
Safety and supply	Central Electricity Authority(measures of safety and electricity supply) Regulations, 2010
Harmonic Requirements Harmonic Current	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013
Synchronization	Photovoltaic system must be equipped with a grid frequency synchronization device. Every time the generating station is synchronized to the electricity system. It shall not cause voltage fluctuation greater than +/- 5% at point of connection.
Voltage	The voltage-operating window should minimize nuisance tripping and should be under operating range of 80% to 110% of the nominal connected voltage. Beyond a clearing time of 2 second, the photovoltaic system must isolate itself from the grid.
Flicker	Operation of Photovoltaic system should not cause
Frequency	When the Distribution system frequency deviates outside the specified conditions (50.5 Hz on upper side and 47.5 Hz on lower side), There should be over and under frequency trip functions with a clearing time of 0.2 seconds.
DC injection	Photovoltaic system should not inject DC power more than 0.5% of full rated output at the interconnection point or 1% of rated inverter output current into distribution system under any operating conditions.
Power Factor	The photovoltaic system in the event of fault, voltage or frequency variations must island/disconnect itself within IEC standard on stipulated period.
Overload and Overheat	The inverter should have the facility to automatically switch off in case of overload or overheating and should restart

	when normal conditions are restored.
Paralleling Device	Paralleling device of photovoltaic system shall be capable of withstanding 220% of the normal voltage at the interconnection point.

9. Connection to the Building Electrical System :

- The AC output of the solar grid inverter shall be connected to the building's electrical system after the service connection meter and main switch on the load side. The solar grid inverter output shall be connected to a dedicated module in the Main Distribution Board (MDB) of the building. It shall not be connected to a nearby load or socket point of the building. The connection to the electrical system of the building shall be done as shown in typical wiring diagram 1 in the Annexure I. For buildings or loads with diesel generator backup, the wiring of the solar grid inverter shall be such that the solar grid inverter cannot run in parallel with the diesel generator. This implies that the solar grid inverter must be connected to a distribution board on the grid side of the automatic or manual change-over switch as shown in typical wiring diagram 2 in the Annexure I.
- The maximum capacity for interconnection with the grid at a specific voltage level shall be as specified in the Distribution Code/Supply Code of the State and amended from time to time. Following criteria have been suggested for selection of voltage level in the distribution system for ready reference of the solar suppliers.

Plant Capacity	Connecting voltage
Up to 8 kW	240V-single phase or 415V-three phase at the option of the consumer
Above 8kW and up to 75 kW	415V – three phase
Above 75kW	At HT/EHT level (11kV/33kV/) as per DISCOM rules

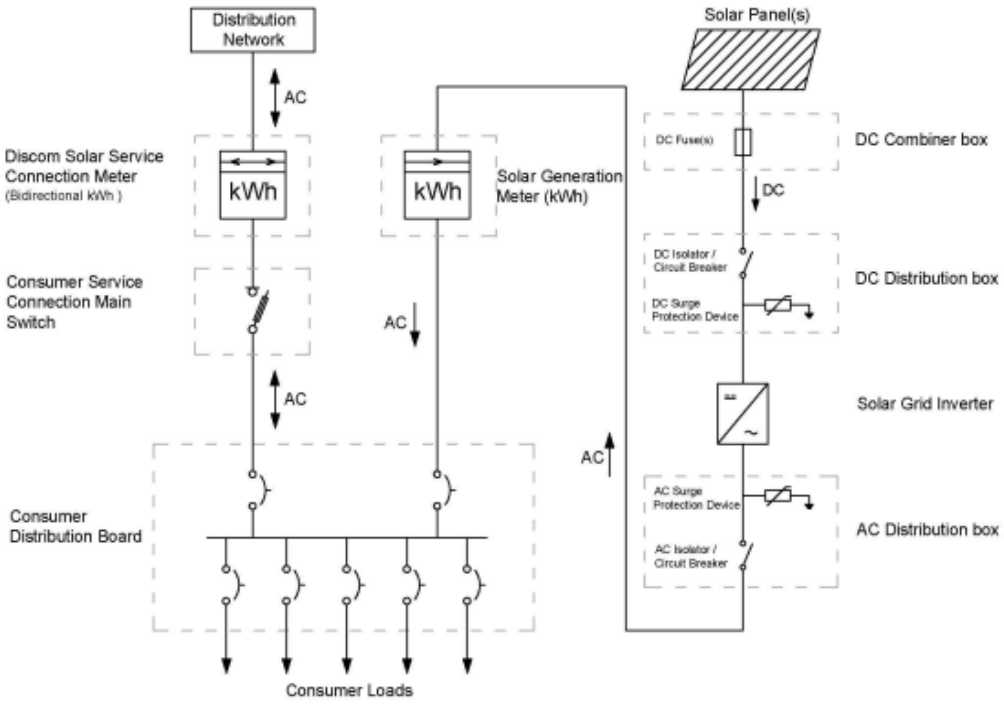
a. The maximum permissible capacity for rooftop shall be 1 MW for a single net metering point.

b. Utilities may have voltage levels other than above, MSPDCL may be consulted before finalization of the voltage level and specification be made accordingly.

10. Meter Configuration options

The metering system for rooftop solar system, under net-metering arrangement, shall be as elaborated below which should be applicable till such time the Central Electricity Authority notifies the standards in this matter.

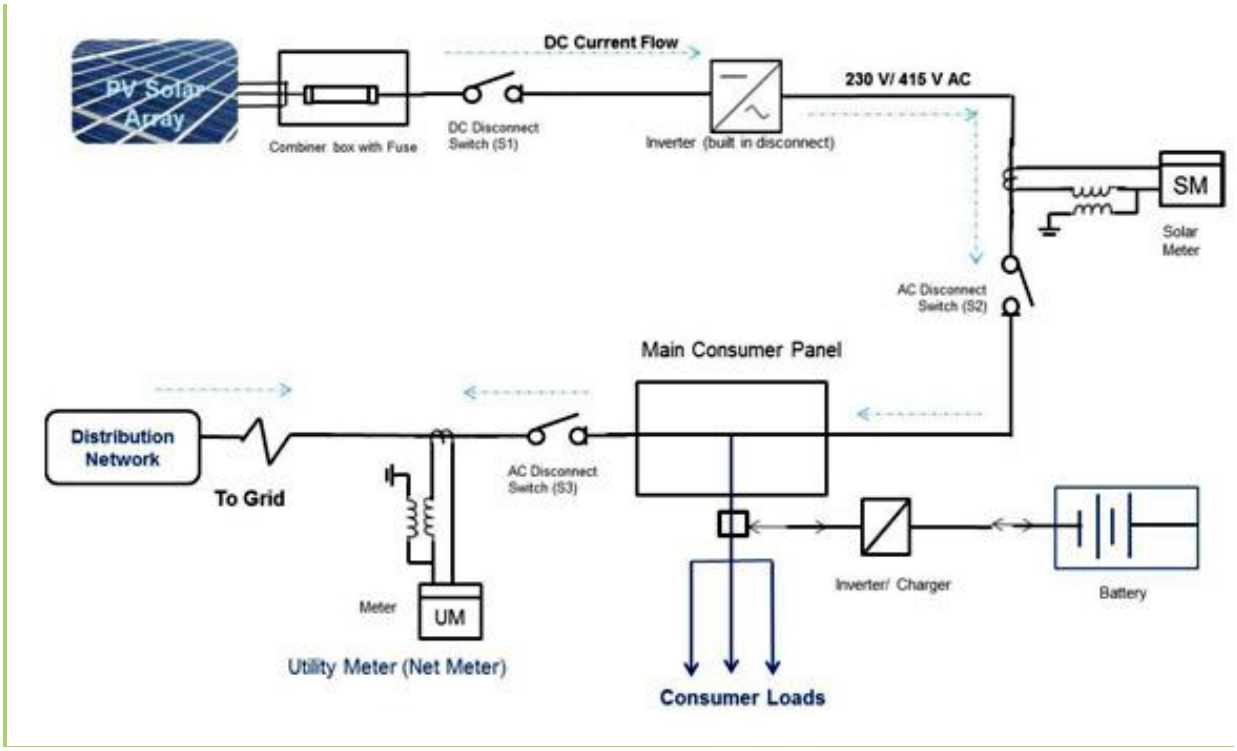
a) Two Meter Configuration without Storage: The metering protocol for 'Grid connected rooftop solar PV system without storage' and location of solar meter and consumer meter shall be in accordance with the schematic below:-



Note: The Solar Generation Meter shown above is mandatory for consumers who avail of a generation-based incentive (GBI) and is optional for others.

The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount.

Two Meter Configuration with Storage : The metering protocol for 'Grid connected rooftop solar PV system with storage' and location of Solar Meter (SM) and Utility Meter (UM) shall be in accordance with the schematic below:-



The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount.

11. TRANSFORMER "IF REQUIRED" & METERING :-

• Dry/oil type relevant kVA, 11kV/415V, 50 Hz Step up along with all protections, switchgears, Vacuum circuit breakers, cables etc. along with required civil work.

• The bidirectional electronic energy meter (0.5 S class) shall be installed for the measurement of import/Export of energy.

• The Channel Partner must take approval/NOC from the MSPDCL for the connectivity, technical feasibility, and synchronization of SPV plant with distribution network before commissioning of SPV plant.

• Reverse power relay shall be provided by Channel Partner (if necessary), as per the MSPDCL requirement.

12. PROTECTIONS :-

• The system should be provided with all necessary protections like earthing, Lightning, and grid islanding as follows:

SURGE PROTECTION :-

• Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and –ve terminals to earth (via Y arrangement).

Surge protection shall be provided on the DC side and the AC side of the solar system. The DC surge protection devices (SPDs) shall be installed in the DC distribution box adjacent to the solar grid inverter.

The AC SPDs shall be installed in the AC distribution box adjacent to the solar grid inverter.

The SPDs earthing terminal shall be connected to earth through the above mentioned dedicated earthing system. The SPDs shall be of type 2 as per IEC 60364-5-53

EARTHING PROTECTION :-

• Each array structure of the PV yard should be grounded/ earthed properly as per IS:3043-1987. In addition the lighting arrester/masts should also be earthed inside the array field. Earth Resistance shall be tested in presence of the representative of MANIREDA as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly. The use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth.

- Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.
- The PV module structure components shall be electrically interconnected and shall be grounded.
- Earthing shall be done in accordance with IS 3043-1986, provided that earthing conductors shall have a minimum size of 6.0 mm2 copper, 10 mm2 aluminium or 70 mm2 hot dip galvanised steel. Unprotected aluminium or copper-clad aluminium conductors shall not be used for final underground connections to earth electrodes.
- A minimum of two separate dedicated and interconnected earth electrodes must be used for the earthing of the solar PV system support structure with a total earth resistance not exceeding 5 Ohm.

The earth electrodes shall have a precast concrete enclosure with a removable lid for inspection and maintenance. The entire earthing system shall comprise non-corrosive components.

GRID ISLANDING :-

• In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as “Islands.” Powered Islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid(due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.

• A manual disconnect 4-pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

13. CABLES :-

• Cables of appropriate size to be used in the system shall have the following characteristics:

a. Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards

b. Temp. Range: –10oC to +80oC.

c. Voltage rating 660/1000V

d. Excellent resistance to heat, cold, water, oil, abrasion, UV radiation

e. Flexible

f. Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum (2%)

g. For the DC cabling, XLPE or, XLPO insulated and sheathed, UV stabilized single core multi-stranded flexible copper cables shall be used; Multi-core cables shall not be used.

h. For the AC cabling, PVC or, XLPE insulated and PVC sheathed single or, multi-core multi-stranded flexible copper cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.

i. The cables (as per IS) should be insulated with a special grade PVC compound formulated for outdoor use. Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour.

j. The DC cables from the SPV module array shall run through a UV stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.

k. Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.

l. All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm2 copper; the minimum AC cable size shall be 4.0 mm2 copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.

m. Cable Routing / Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified. In addition, cable drum no. / Batch no. to be embossed/ printed at every one meter.

n. Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.

o. All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes **for 25 years and voltages as per latest IEC standards**. DC cables used from solar modules to array junction box shall be solar grade **copper (Cu) with XLPO insulation and rated for 1.1kV** as per relevant standards only.

p. The ratings given are approximate. EoI holder to indicate size and length as per system design requirement. All the cables required for the plant shall be provided by the EoI holder. Any change in cabling sizes if desired by the EoI holder shall be approved after citing appropriate reasons. All cable schedules/ layout drawings shall be approved prior to installation.

q. Multi Strand, Annealed high conductivity copper conductor PVC type ‘A’ pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection **Armoured cable for underground laying**. All cable trays including covers to be provided.

r. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including 1100 V, UV resistant for outdoor installation IS /IEC 69947.

s. The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.

t. The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%.

u.The following colour coding shall be used for cable wires: − DC positive: red (the outer PVC sheath can be black with a red line marking) − DC negative: black − AC single phase: Phase: red; neutral: black − AC three phase: Phases: red, yellow, blue; neutral: black − Earth wires: green

v. Cables and conduits that have to pass through walls or ceilings shall be taken through a PVC pipe sleeve.

w. Cable conductors shall be terminated with tinned copper end-ferrules to prevent fraying and breaking of individual wire strands. The termination of the DC and AC cables at the Solar Grid Inverter shall be done as per instructions of the manufacturer, which in most cases will include the use of special connectors.

14. DATA ACQUISITION SYSTEM / PLANT MONITORING :-

- Data Acquisition System shall be provided for each of the solar PV plant above 10 kWp capacity.
- Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.
- Temperature: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system.
- The following parameters are accessible via the operating interface display in real time separately for solar power plant:

a. AC Voltage.	b. AC Output current.	c. Output Power
d. Power factor.	e. DC Input Voltage.	f. DC Input Current.

g. Time Active.	h. Time disabled.	i. Time Idle.
j. Power produced	k. Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.	

All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.

- PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.5 accuracy class. Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.

- String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.

- Computerized AC energy monitoring shall be in addition to the digital AC energy meter.

- The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.

- All instantaneous data shall be shown on the computer screen.

- Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

- Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.

  Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.

- Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

- Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.
- Remote Monitoring and data acquisition through Remote Monitoring System software at the owner / MANIREDA location with latest software/hardware configuration and service connectivity for online / real time data monitoring / control complete to be supplied and operation and maintenance / control to be ensured by the EoI holder.

The empanelled channel Partner shall be obligated to push real-time plant monitoring data on a specified intervals (say 15 minute) through open protocol at receiver location (cloud server) in XML/JSON format, preferably. Suitable provision in this regard will be intimated to the Channel Partner.

15. TOOLS & TACKLES AND SPARES :-

• After completion of installation & commissioning of the power plant, necessary tools & tackles are to be provided free of cost by the EoI holder for maintenance purpose. List of tools and tackles to be supplied by the EoI holder for approval of specifications and make from MANIREDA.

• A list of requisite spares in case of PCU/inverter comprising of a set of control logic cards, IGBT driver cards etc. Junction Boxes. Fuses, MOVs / arrestors, MCCBs etc along with spare set of PV modules be indicated, which shall be supplied along with the equipment. A minimum set of spares shall be maintained in the plant itself for the entire period of warranty and Operation & Maintenance which upon its use shall be replenished.

The Installer shall keep ready stock of tools, tackles and essential spares that will be needed for the day-to-day maintenance of the solar PV system. This shall include but not be limited to, the following:

- Screw driver suitable for the junction boxes and combiner boxes;
- Screw driver and / or Allen key suitable for the connectors, power distribution blocks, circuit breaker terminals and surge arrestor terminals;
- Spanners / box spanners suitable for the removal of solar PV modules from the solar PV module support structure;
- Solar panel mounting clamps;
- Cleaning tools for the cleaning of the solar PV modules;
- Spare fuses.

16. DANGER BOARDS AND SIGNAGES :-

• Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Three signage shall be provided one each at battery –cum- control room, solar array area and main entry from administrative block. Text of the signage may be finalized in consultation with MANIREDA/ owner.

17.FIRE EXTINGUISHERS :-

• The firefighting system for the proposed power plant for fire protection shall be consisting of:

a. Portable fire extinguishers in the control room for fire caused by electrical short circuits.

b. Sand buckets in the control room.

c. The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof or site where the PV arrays have been installed.

18.DRAWINGS & MANUALS :-

• Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied. EoI holders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their EoI along with basic design of the power plant and power evacuation, synchronization along with protection equipment.

• Approved ISI and reputed makes for equipment be used.

For complete electro-mechanical works, EoI holders shall supply complete design, details and drawings for approval to owners/MANIREDA before progressing with the installation work.

19.PLANNING AND DESIGNING:

• The EoI holder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labour. The EoI holder should submit the array layout drawings along with Shadow Analysis Report to owner for approval.

DRAWINGS TO BE FURNISHED BY CHANNEL PARTNER AFTER AWARD OF CONTRACT FROM BENEFICIARY:-

• The Contractor shall furnish the following drawings Award/Intent and obtain approval

• General arrangement and dimensioned layout.

• Schematic drawing showing the requirement of SV panel, Power conditioning inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.

• Structural drawing along with foundation details for the structure.

• Itemized bill of material for complete SV plant covering all the components and associated accessories.

• Layout of solar Power Array

• Shadow analysis of the roof

20. Quality and Workmanship

Solar PV modules are designed to last 25 years or more. It is therefore essential that all system components and parts, including the mounting structures, cables, junction boxes, distribution boxes and other parts also have a life cycle of at least 25 years. Therefore all works shall be undertaken with the highest levels of quality and workmanship. During inspection special attention will be given to neatness of work execution and conformity with quality and safety norms. Non-compliant works will have to be redone at the cost of the Installer.

21. DISPLAY BOARD :-

The EoI holder has to display a board at the project site (above 10 kWp) mentioning the following:

a. Plant Name, Capacity, Location, Type of Renewable Energy plant (Like solar wind etc.), Date of commissioning, details of tie-up with transmission and distribution companies, Power generation and Export FY wise.
b. Financial Assistance details from MANIREDA/MNRE/Any other financial institution apart from loan. This information shall not be limited to project site but also be displayed at site offices/head quarter offices of the successful EoI holder.

c. The size and type of board and display shall be appropriate.