

VOLUME - II



**EPC PACKAGE WITH LAND FOR DEVELOPMENT OF  
UP TO 500 MW (AC) SOLAR PV PROJECT ANYWHERE IN  
THE STATE OF GUJARAT**

**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

PART – 2 (A)  
SHEET 1 of 96

**VOLUME – II**

**PART – 2**

**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**TABLE OF CONTENTS**

<b>Section</b>	<b>Description</b>	<b>PAGE NO.</b>
	<b><u>SCHEDULE-III</u></b>	
	<u>EPC Technical Specification</u>	3
<b>A</b>	<b><u>DC SYSTEM</u></b>	
A.1	<u>PV Connectors and Branch Connectors</u>	3
A.2	<u>Module Mounting Structure (Mms)/ Tracker System</u>	7
A.3	<u>String Combiner Box</u>	24
A.4	<u>Inverters</u>	31
A.5	<u>Solar Cables</u>	49
A.6	<u>SCB to Inverter Cable (1.9/3.3 kV)</u>	56
A.7	<u>Module Cleaning System</u>	63
A.8	<u>ESE Lightning Arrestor for PV Yard</u>	71
A.9	<u>Weather Monitoring System</u>	74
A.10	<u>Solar Photovoltaic (Spv) Modules</u>	84



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**SCHEDULE – III EPC TECHNICAL SPECIFICATION**

**DC SYSTEM**

**A1 - PV CONNECTORS AND BRANCH CONNECTORS**

**1.0 PV Connectors and Branch Connector**

The PV connectors shall be designed, engineered, manufactured and tested to achieve high availability and reliability. The design and engineering shall make use of most recent international standards and best design practices.

The vendor shall supply all specialized equipment such as Crimping, Unlocking, tightening etc. and specialised services required for this purpose.

**2.0 Codes & Standards**

<b>Codes</b>	<b>Description</b>
UL 746C	UV Resistant
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 62852	Connectors for Photovoltaic system
IEC 60352	Crimped connections – general requirement, test methods and practical guide
UL94-V0	Flame Class
IEC 62262	Level of Protection against Mechanical Impact (IK Rating)
BS EN 50521	Safety requirements and tests
IEC 61730	Photovoltaic module safety qualification
EN 60695	Fire Hazard testing

**3.0 Design Criteria**

3.1 The connectors shall be of 1500V DC grade.


**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.2 The connectors shall be UV resistant, ozone resistant, halogen free, dust-proof, non-conductive, ammonia resistant, non-inflammable and suitable for climatic condition of the site exposed to direct sunlight.
- 3.3 The connectors shall be manufactured with Polyphenylene Ether (PPE) insulation having tin plated copper pin contacts.
- 3.4 The usage of Y-connector is acceptable. However, in-line fuses must be provided as below:
- a) For central inverter configuration with negative grounding system, in-line fuses as per sizing calculation shall be provided in the positive terminal of Y-connector.
- 3.5 The fuses shall be replaceable type and compatible with the Y-connector.
- 3.6 Connector shall have slots for accepting “snap-in” type of locking tabs.
- 3.7 The connectors shall be suitable for standard crimping tools

**4.0 Technical Parameters**

Sl. No.	Item Description	Unit	Data
1.	Type	-	PV Connector and Branch Connector, snap-in locking type
2.	Designation	-	Male and Female
3.	Rated Voltage	V DC	1500
4.	Highest System Voltage	V DC	1800
5.	Connector Cable Cross-section	Sq. mm	4 or 6 sq. mm
6.	Insulating Material	-	Polycarbonate
7.	Contact Material	-	Copper tin plated
8.	Rated Current	A	30 or higher as per design
9.	Rated Test Voltage	kV	8 (1 min)
10.	Rated Impulse Voltage	kV	16
11.	Ambient Temperature	°C	50
12.	Operating Temperature Range	°C	-40°C to +90°C
13.	Upper Limiting Temperature	°C	115



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Data
14.	Degree of Protection	-	IP68 (mated connection), IP2X (unmated connection)
15.	Protection / Safety Class	-	Class II
16.	Overvoltage Category	-	Cat III
17.	Contact resistance	m-Ω	<0.5
18.	Flammability Class	-	UL94V-0
19.	Insertion Force	N	≤ 50
20.	Withdrawal Force	N	≥ 50

### 5.0 Testing Requirements

The following minimum tests shall be performed on connectors:

- a) Contact resistance at termination.
- b) Spark test.
- c) Degree of protection.
- d) HV test in water
- e) Mechanical Test
  - i. Durability of marking.
  - ii. Termination & connection methods.
  - iii. Contact retention force in insert.
  - iv. Cable clamp (pull).
  - v. Cable clamp (torsion).
  - vi. Mechanical strength impact.
  - vii. Mechanical strength at lower temperature.
  - viii. Insertion force (Mating force).
  - ix. Withdrawal force (Un-mating force).
  - x. Effectiveness of connector coupling device (Separation force).
- f) Service Life Tests
  - i. Contact resistance (Initial).
  - ii. Mechanical operation (Durability).
  - iii. Contact resistance (Final).
  - iv. Bending test (Flexing).
- g) Thermal Test (Mated Test Specimen)
  - i. Contact resistance (Before and after temperature rise)
  - ii. Temperature rise test



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- h) Protection Test
  - i. Dielectric voltage withstand test (Voltage proof).
  - ii. Flammability (Enclosure).
  - iii. Flammability (Support for live part).
  - iv. UV radiation test.
- i) Confirmation on connector compatibility in case of different makes.

**6.0 Data to be furnished by vendor after award of contract:**

**A. Drawings / Documents for Approval:**

- i. GA & Cross-sectional drawings of each Y-Connector.
- ii. Guaranteed Technical Particulars for Y-Connectors.
- iii. Drawing showing the terminal connection.
- iv. Detailed quality assurance plan.
- v. Any other drawings/documents considered necessary.
- vi. Quality certifications from TUV/UL

**B. Drawings / Documents for information:**

- i. Type test certificates valid for five years for all equipment/accessories being supplied under this contract.
- ii. Routine test certificates for all equipment/accessories being supplied under this contract.
- iii. Instruction manual containing detailed instructions for all erection, testing and operation requirements.
- iv. Detailed instructions for the installation and operation.
- v. All detailed catalogues and literature of the Connectors supplied.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A2 – MODULE MOUNTING STRUCTURE (MMS)/ TRACKER SYSTEM (if applicable)**

**1.0. GENERAL**

Module Mounting Structures (MMS) made of Metallic structures having adequate strength and appropriate design, to withstand various loads on the MMS including design wind pressures. Modules shall be mounted on noncorrosive support structures. In case bidder is proposing the Tracker system then it shall be Self Powered and Automatic motor powered Realtime tracking system.

The Bidder may propose one of the arrangement or combination of both for mounting PV Modules for proposed each Solar PV Project.

- a) Fixed Tilt Module Mounting Structure (MMS) or
- b) Module Mounting Structure with Tracker System

The Bidder shall please note that relevant clauses of the Technical Specifications shall be applicable to above mentioned PV module arrangements.

**2.0. TRACKER SYSTEM (if applicable)**

2.1 The Tracker System shall be of proven design capable of tracking Sun's path actively, intended to maximize the energy output from PV Module. Design shall be based in accordance with the site climatic conditions and seismic loads, soil characteristics, thermal loads caused by expected fluctuations of materials and ambient temperatures and the minimum required design wind speed.

2.2 The design shall allow easy installation and replacement of any position PV module in the table. The Bidder shall specify installation details of the PV modules, on the support structures, which shall also accommodate robotic cleaning system, with appropriate design, and drawings.

2.3 The Bidder shall submit the detailed design calculations and drawings for MMS structure, bill of materials and their specifications / standards to the Owner for approval before fabrication commencement.

**3.0. CODES & STANDARDS**

3.1 The work to be executed under this specification shall be in accordance with the applicable section of the latest version of the relevant IS standards including amendments, if any, except where modified and / or supplemented by this specification.

3.2 Equivalent National and International standard/code would also be acceptable for Module Mounting structures (MMS) with trackers system (if applicable).

3.3 Some of the applicable codes and standards are as mentioned below.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures
IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads
IS : 1893	Criteria for earthquake resistant design of structures
IS 811	Cold formed light gauge structural steel sections
IS 2062	Hot rolled Medium and High tensile structural steel
IS : 209	Zinc Ingot
IS 2629	Recommended practice for hot-dip galvanizing of iron and steel
IS 800: 2007	Code of practice for use of structural steel in general building construction
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 1868	Anodic Coatings on Aluminium and its Alloys
IS 15961	Hot dip aluminium-zinc alloy metallic coated steel strip and sheet (plain)
IS 9172	Recommended design practice for corrosion prevention of steel structures.
ISO-12944	Corrosion protection of steel structures by protective paint systems for C5-M zone for very high saline zone
IS 4923	Hollow steel sections for structural use.
IS 1161	Steel tubes for structural purposes
IS 4736	Hot-dip zinc coatings on mild steel tubes
UL 2703	Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels or equivalent
UL 3703	Standard for Solar Trackers or equivalent
IEC TS 62727	Photovoltaic systems - Specification for solar trackers
IEC 62817:2014+ AMD1:2017 CSV:	Photovoltaic systems – Design qualification of solar trackers

#### **4.0. DESIGN PARAMETERS**

- 4.1 Only single axis East-West real time tracking
- 4.2 Configuration - Both, single and multi-rows options are accepted.
- 4.3 Individual row-level bi-directional control
- 4.4 Tracker Range of Movement (ROM): +/- 60 degrees or better or as required to achieve targeted generation
- 4.5 DC Self-powered drive system with battery backup of 3 days autonomy.
- 4.6 Redundant communication (Wired/wireless) through meshed network topology for individual Trackers
- 4.7 Integration to Plant SCADA
- 4.8 Stow configuration: optimal Angle, as per aero elastic instability analysis.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 4.9 Design wind speed as per site condition, basic wind speed as per wind map of India from IS 875 Part 3: 2015.
- 4.10 Suitable material for corrosion category compliance as per Corrosion map of India, EN ISO 14713, EN ISO 1461, EN ISO 12944-5 or ASTM 123.
- 4.11 Operational temp: -10 to 50 degree Celsius or as per CEA Guidelines/Working committee report whichever is higher.
- 4.12 Cleaning - Comply with robotic module cleaning system
- 4.13 Minimum ground clearance to be maintain at module edge with maximum angle shall not be less than 400mm. However, this will be decided based on final document shared by bidder and approved by OWNER. Further, the structure height shall be designed considering highest flood level at site. The min. clearance between lower edge of the Module and the ground level shall be higher of (i) highest flood level at site and (ii) min. 400 mm.

**5.0. MINIMUM SYSTEM REQUIREMENTS**

- 5.1 Tracking system shall be followed by either means of sun's positioning algorithm or backtracking philosophy or optimization algorithm with a minimum tracking accuracy of  $\pm 2^\circ$  between the pointing vector of the sun and the pointing vector of the modules.
- 5.2 The algorithm shall optimize irradiance for both row avoidance shading and diffuse light optimization.
- 5.3 Tracker shall be equipped with safety features like, auto high wind stow to the designed angular position and shall have uninterrupted communication with monitoring console/station. It should be capable of sending alarms to the monitoring station in case of failure or abnormal operations of the tracking systems.
- 5.4 For each row a copper earthing cable / wire jumper shall be installed to interconnect all metallic parts of foundation, tracker structure and PV modules of each table.
- 5.5 All local tracking controls shall be mounted on the tracking structure. A suitable arrangement/bellows shall be provisioned to protect actuator assembly from extreme outdoor harsh condition, dust and UV rays.
- 5.6 In case of failure of supply, the arrays should return to the stow position. Bidder shall supply a tracking mechanism with an inbuilt feature for meeting the requirement.
- 5.7 All modules associated with a specific tracking system should be connected to a common inverter.
- 5.8 Suitable redundancy in sensing and auxiliary power supply shall be provided for fail-safe stowing of trackers. Redundancy in control is also desirable for the safe operation of trackers. Detail of the scheme for various redundancy shall be finalized at the time of detailed engineering.
- 5.9 Safety measures such as stop devices shall be applied to ensure personal safety.
- 5.10 Tracker design shall also include a provision for fastening DC cables to the structure each 500mm interval without causing tearing or fluttering of cables.
- 5.11 Tracker shall be able to track as per proposed stow strategy supported by Wind Tunnel test.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 5.12 For trackers that rely on active stowing to resist maximum design wind speeds, a 'fail to stow' load combination shall be considered.
- 5.13 Tracker Torque Tubes should be galvanized in accordance with, ISO 1461, ISO 14713, ISO 9223, or relevant standard as per Corrosive Category of proposed Solar PV Site.
- 5.14 The mechanical system which enables the rotation of the tracker system shall be provided with suitable coating material which will not get damaged or lost during the rotation operation over 25 years. Alternatively, in place of coating the parts can be manufactured with suitable corrosion resistant material.

**6.0. MODULE MOUNTING ARRANGEMENT**

- 6.1 The module mounting structure design shall be appropriate, safe, and innovative. The MMS structure should be design for optimum tilt angle (Fixed/single axis tracking) so as to meet the offered NEEGG by Bidder. It shall follow the existing land profile or graded profile. The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirements. Design drawings with material selected and their standards shall be submitted for prior approval of OWNER within 15 days of award of work.
- 6.2 The support structure & foundation shall be designed with reference to the recommendations provided in the approved soil investigation report and considering total Project life of at least 25 years.
- 6.3 The structure should be safe and shall be designed for simple mechanical and electrical installation and allow easy replacement of any PV modules and easy access to the O&M staff. It shall support SPV modules at a given orientation & tilt, absorb and transfer the mechanical loads to the ground properly. Welding of structure at site shall not be allowed.
- 6.4 The Ground mounting structure system which constitutes a photovoltaic array(s) shall be designed to withstand the extreme fair wind (positive pressure) and adverse wind (negative pressure) on design tilt angle of solar photovoltaic array(s). The design calculations shall be supplemented with neat sketch and reference to various clauses of technical specification and Indian standards.
- 6.5 Following wind pressure generated loads shall be considered in the analysis and design.
- (i) Load on members, fittings & panels.
  - (ii) Load due to fair wind direction on design tilt angles of solar mounting structural members.
  - (iii) Load due to adverse wind direction on design tilt angles of solar mounting structural members.
  - (iv) Load on side face of mounting structural members.
  - (v) Load due to robotic cleaning system and any other load envisaged.
- 6.6 Wind pressure coefficient, load and load combination shall be as per Indian standards (latest revision) such as IS: 875, IS: 800. An increase in allowable stresses of structural material should not be considered during design and analysis.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 6.7 The limiting permissible vertical deflection for structural steel members shall be as given below.
- i. Maximum vertical deflection of purlin =  $\text{Span}/180$
  - ii. Maximum vertical deflection of rafter (cantilever & simple span) =  $\text{Span}/180$
  - iii. Maximum lateral deflection of column post =  $\text{Height}/240$ .
  - iv. All deflection limits can also be as per the serviceability limit defined by the module manufacturer & tracker manufacturer OR the proposed deflection limits duly approved by the module manufacturer and additional moment along with dead load shall be considered during detailed engineering.

- 6.8 Top of concrete or height of Pile cap/ height of collar for MMS foundation shall be minimum 400 mm above NGL and anti-corrosive paint shall be applied (as per local site condition and decision of Owner shall be final and binding to Contractor) up to 600 mm above NGL (400 mm Pile cap + 200 mm Column Post). The minimum plan area of MMS foundation collar shall be 700 sq. cm.

- 6.9 Following types of foundation may be provided based on the recommendations of soil investigation report.

- a) Bored cast In-situ pile (Min. 300mm dia.)
- b) Isolated, strip or raft foundation
- c) Concrete ballast foundation

However, the type of foundation shall be decided based on final geotechnical investigation report and based on OWNER's approval. The foundation proposed for the plant shall meet all the safety and risk envisaged for the plant.

The Bidder has to plan for pile load test like pull out, lateral and compression are required to be conducted for each plot at strategic location, immediately after receiving Lol. The same shall be furnished for approval of the Owner, based on the results of above-mentioned tests, final approval for design of pile shall be provided.

- 6.10 MMS frames, post, base plate, assembly of the array structures, etc. shall be of MS hot dip galvanized. Hot dip galvanization shall be as per IS: 4759 or relevant Indian standard and the coating thickness shall be maintained as defined below at any point of the structure. Galvanization shall be measure with elcometer or the material can be sent for testing laboratory as and when required. No averaging is allowed for measuring the thickness of galvanization. Inner side galvanization with same specification of any hollow components of module mounting structure is mandatory. Column/ Vertical Post, Bracing Rafter, Beam, Purlin, Steel Tubes in all sections, Hollow Steel in all sections, Coupler/Plate/Cleat Splice/Sag Angle shall have the minimum thickness as specified in below table.

- 6.11 MMS frames, post, base plate, assembly of the array structures, etc. shall conform to Indian standards as mentioned in the list of code.
- (a) IS: 2062 (Latest) - Hot Rolled Medium and High Tensile Structural Steel



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

(b) IS: 811 (Latest) - Cold Formed Light Gauge Structural Steel Sections

(c) IS: 1161 (Latest) - Steel Tubes for Structural Purposes

(d) IS: 4923 (Latest) - Hollow steel sections for structural use

**6.12 Materials Specification & Coating for Structural Steel Works (All the structures used in this project):**

**A. Hot-rolled/Cold-formed steel sections:**

A. Hot-rolled/Cold-formed steel sections:						
Members	Reference code	Yield strength, min, MPa	300 mm Above the Ground		Below ground and up to 300 mm above Ground	
			Coating, Reference code	Min Thickness (mm)	Coating Reference code	Min Thickness (mm)
Column/ Vertical Post	IS 2062 / IS 1079	250	80 micron (IS 4759) (minimum)	2.0	For: <b>high Saline Zone and extreme weather condition-</b> 110 micron	3.0
Bracing/Rafter/ Beam/Purlin				2.0		
Steel Tubes in all sections	IS 1161	240		2.0		
Hollow Steel in all sections	IS 4923	240		2.0		
Coupler/Plate/Cleat Splice/Sag Angle	IS 2062	250		2.0	For: Other Site/Location 80 micron <b>at any point of Galvanization, no averaging is allowed</b> (IS 4759) (minimum)	2.0
Rafter/ Beam/ Purlin (Pre-Galvanized steel sections)	ASTM A653M/ IS 1079	255-550	Z600 (ASTM A653M/ IS 277)	1.6	Not recommended in coastal areas	
NOTE:	<ol style="list-style-type: none"> <li>Minimum elongation % shall be as per relevant Standard and Code.</li> <li>Materials shall be fabricated in the shop.</li> <li>Minimum coating requirement mentioned above in the table.</li> <li>All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT i.e., the lower limit of BMT is to be considered.</li> </ol>					



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

5. The tolerance on Base Metal Thickness (BMT) thickness of steel shall be as given in IS 1852.

**B. Hot-dip Aluminium-Zinc alloy metallic coated sheet steel strip and sheet sections:**

<b>B. Hot-dip Aluminium-Zinc alloy metallic coated sheet steel strip and sheet sections:</b>					
<b>Members</b>	<b>Reference code</b>	<b>Yield strength, MPa</b>	<b>Coating Class Designation</b>	<b>Min Thickness (mm)</b>	<b>Coastal Area</b>
Rafter/ Beam	ASTM A792M/ IS 15961	250 - 550	AZM 165 (ASTM A792M) / (IS 15961)	1.2	Not recommended in coastal areas
Purlin	ASTM A792M/ IS 15961	250 - 550	<b>AZM165</b> (ASTM A792M) / (IS 15961)	0.9	Not recommended in coastal areas
NOTE:	<ol style="list-style-type: none"> <li>Minimum elongation % shall be as per relevant Standard and Code.</li> <li>Materials shall be fabricated in the shop.</li> <li>Minimum coating requirement mentioned above in the table.</li> <li>All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT i.e., the lower limit of BMT is to be considered.</li> <li>The tolerance on Base Metal Thickness (BMT) thickness of steel sheets and coils shall be as given in IS/ISO 16163</li> </ol>				

Bidder shall also use principles governing design that shall prevent or reduce the risks of corrosion as per IS 9172 and other relevant IS codes.

- 6.13 Bidder shall submit all the test documents and test certificates complying with the requirement of the structure.
- 6.14 Bidder shall ensure that before galvanization the steel surface shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such foreign material as are likely to interfere with the galvanization process. The Bidder shall also ensure that inner side shall also be galvanized.
- 6.15 Deleted
- 6.16 The Bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 6.17 Module mounting structures shall be so designed that it will occupy minimum space without sacrificing the output from Solar PV panels at the same time it will withstand the extreme weather conditions (like severe Cyclonic storm etc.) in the area. The site design wind speed factors  $k_1$ ,  $k_2$ ,  $k_3$  and  $k_4$  and pressure coefficient shall conform to IS 875 (Part-3): 2015 or as per a Wind Tunnel Study from a reputed national/international facility, for the design of MMS. However, design wind pressure to be considered for design, shall not be taken less than the minimum wind pressure “ $p_d$ ” as mentioned in the Specification.
- 6.18 If the Bidder is going for wind tunnel test for the analysis & design of complete MMS and solar tracking system following shall be ensured.
- i. It must be done from an institute of repute (IITs / CSIR-SERC / CPP Wind Engineering / RWDI or equivalent) in Indian / international facility.
  - ii. If the study is done by any reputed international facility the study results must be vetted by the wind domain expert at any of the IITs / SERC like institutes in India.
  - iii. Bidders must ensure that offered tracker has proven design with wind tunnel test simulating relevant site conditions. The analysis and design shall be completed within two months from the actual date of issue of LOI.
  - iv. Tests and design must comply with relevant Indian/ International codes.
  - v. The design shall be shown in STAAD pro or similar commercially available software for further checking by GIPCL as and when required along with editable supporting files.
  - vi. site-specific design parameters.
- 6.19 The structural material and design shall be as per Design Criteria for Module Mounting Structures (MMS)/Tracker. The structural Material Yield Strength and Minimum Design Thickness can be as per “Proprietary Design” of Tracker supplier, and It shall confirm to relevant Indian / international codal design provisions. The Proposed Solar PV tracker system should be certified for successful performance of MMS and tracker system by designer for its design life of minimum 25 Years after COD. The Solar PV tracker system shall also fulfil the requirements of proveness criteria.
- In case, String Combiner Box (SCB) is mounted on the Module Mounting structures in case of fix type MMS, the contractor shall to take into consideration the load of SCB during design of MMS. Further suitable supporting members for mounting the SCB on the MMS shall also be in the scope of the Contractor. Separate structures for the mounting of SCB shall be considered for Tracker type MMS.
- 6.20 The design and the calculations for the MMS and the foundation system shall be submitted along with calculations and bases/ standard, Bill of Materials, entire specifications, STAAD PRO Analysis Report, Shadow analysis report showing the effect of shadow of various structures and buildings on the energy output of PV Array as per the Engineering Information Schedule for prior approval of GIPCL before the commencement of construction and shall be based on the soil Geotechnical Investigation report.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 6.21 Further details related to structures and foundations have been mentioned in the chapter on civil works of these specifications.
- 6.22 The Structure shall be analysed and designed in accordance with finite element method and the fundamental principles of Engineering using commercially available software (such as STAAD pro or similar), with dead loads and imposed loads considered as per IS 875 (Part 1 & 2) respectively, and with wind loads considered as per IS 875 (Part 3) or as per Wind Tunnel study done from a reputed national/international facility (IITs / CSIR-SERC / CPP Wind Engineering / RWDI or equivalent). Analysis shall be done as per appropriate load combinations as per IS codes.
- 6.23 Seismic factors for the site to be considered while making the design of the foundation/ramming etc. or any technology. The design of array structure shall be based on soil test report of the site and shall be approved from the Owner/ Consultant. Before final approval of drawing/design pile foundation for any type of structure pile load test shall be conducted and result shall be submitted to GIPCL.
- 6.24 The Structure must be provided with limit switches to control the rotation of the frame.
- 6.25 All nuts & bolts or clamps shall be of Stainless steel, Aluminium or Metal Alloy type for a module to structure connection, and other structural bolts shall be of grade HDG 5.6 or 8.8 or exclusively designed for solar tracker systems by manufacturers. Which should suffice the design life for 25 years and more for Corrosive Category proposed for Solar Park and confirm to Indian / international codal provision.
- i. SS304 Fasteners (nuts, bolts, washers, and U-bolts) shall be of corrosion-resistant austenitic steel. SS 304 Fasteners shall have a good anti-seize finish with proper wax coating for better durability and firm resistance to all types of failure including seasonal removal and re-fixing of bolts.
  - ii. All fasteners shall be provided according to the connection design requirement. All bolts shall be tightened with designed torque mechanically immediately after the erection of MMS to avoid any possible damage due to any incidental storm during the erection stage. All fasteners shall be designed for increased local wind pressure on panels as per IS: 875 (Part-3).
  - iii. One set of fasteners shall consist of one hexagonal head nut, one hexagon shape bolt, and two Plain Washers and one serrated washer or as per the requirement of PV Module manufacturer washers. The bots and nuts with inbuilt washers may also be provided.
- 6.26 Modules shall be clamped / bolted with the structure properly. The material of construction shall be Al / Steel. Clamps / bolts shall be designed in such a way so as not to cast any shadow on the active part of a module.
- 6.27 Module mounting structures shall also be earthed through proper separate earthing.
- 6.28 The material of construction, structural design and workmanship shall be appropriate with a factor of safety of not less than 1.5 in all types of checks in design calculations. For multiple



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

mounting structures located in a single row, the alignment of all Modules shall be within an error limit of max. 10 mm in vertical/horizontal line.

6.29 Curing of all piles shall be done thrice a day and be maintained for a period of seven days from the date of casting (if applicable)

**6.30 PROTECTION AGAINST CORROSION & UV**

a) Appropriate measures shall be considered, as required, to protect the structure, foundation, and all components against corrosion during the expected lifetime of the Plant. Structural steel shall be hot dip galvanized as mentioned elsewhere in this document with minimum thickness of coating on each side at any point of the Structure. Galvanization shall be measure with elcometer or the material can be sent for testing laboratory as and when required. No averaging is allowed for measuring the thickness of galvanization. Galvanization shall be done as per ISO 1461 (or BS 729), EN 10346, ISO 14713, IS 4759, ISO 9223 and as per Corrosive Category of proposed Solar PV Site.

b) Non-metallic materials placed outdoors shall be UV and sand resistant and withstand high ambient temperature operation regimes as per the climatic conditions over the whole Plant design lifetime, and where materials are specified in any part of this specification, those characteristics are to be considered as a minimum requirement. Metallic materials are not explicitly required to be UV resistant but in case protective coating is required, this shall be UV and sand resistant.

c) All materials used for concrete, reinforced concrete structures, steel structures, aluminium structures or structural elements or any other building material shall be of high quality, free from defects likely to undermine the strength and duration of service of the Plant.

**6.31 BEARING & ENDCAPS**

a) The bearing should be type tested for operation cycles which solar plant will go through in its life of 25 years.

b) Preferably there should not be any lubrication in the bearing, but if there is any, then it should be maintenance free. No cleaning should be needed.

c) The bearing should also be resistant to dust, water and any other external parameters.

d) End Caps shall be provided at both ends of each row to close the hollow sections of Row tubes or Torque tubes. Type of Material and Design shall be submitted by Bidder for Owner approval during detail engineering.

**6.32 MOTOR AND ACTUATOR**

a) The motor should be IP 65 or better and it should be powered by reliable supply to drive the link through gear or hydraulic/electric actuator. Battery shall be installed in such a way that it can be easily replaceable at site. Plant power shall not be used for operating the tracker motors.

b) The temperature rises in the motor during operation specified in IS12802: 1989 should not be more than approximately 10°C.

c) The location and moisture or fumes shall not seriously interfere with the operation of the motor.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- d) The severity of vibration for the motors shall be within the limits specified in IS 12075: 1987.

**6.33 CONTROLLERS**

- a) Trackers should have an industrial grade system for its automatic control and operations. For all outdoor controllers, it should be housed in IP-65 enclosure.
- b) The controller must be enabled with a feature of stowing during high-speed winds.
- c) The Real Time Clock (RTC) of the trackers shall have a facility to be time synchronized with SCADA on Network Time Protocol (NTP).
- d) A suitable communication link between the master controller of tracker and tracker SCADA system shall be arranged. The software for communication and analysis shall be provided by the tracker supplier. Tracker SCADA shall be interfaced with solar SCADA on an open protocol such as MODBUS.
- e) Battery back-up should be provided for Controller and motor as per design specified in Cl 4.0. Alternatively, the bidder can provide backup power from the UPS of inverter room.

**6.34 STUDIES/REPORTS**

The following studies, and reports shall be submitted by the Bidder for the offered solution. The studies and reports shall provide a positive outcome of the respective tests, designs, and concepts for the utilization of the proposed single axis tracking system in the Project:

- a) Stow strategy control system: The Tracker supplier is solely responsible for the definition and implementation of a proper stow strategy, which clearly demonstrates and guarantees the safe operation of the tracker during all wind events with speed up to and including the maximum one defined as per local structural code. The following points, including but not limited to, should be made available as part of the safety stow strategy:
  - i. Tracker inclination and orientation at safety stow position
  - ii. Maximum wind speed in [m/s] as [3-sec gust / 10min average] defined at 10m height which the tracker can withstand in working position
  - iii. Stow alarm function and wind speed at which it is triggered
  - iv. Safety strategy during installation / commissioning
  - v. In case that batteries are used, which is the minimum charge level required in order to reach safety stow position
  - vi. Security of communication protocols required for the active stow
  - vii. Time requirement to move the tracker from working position into stow position considering also safety factors
  - viii. System redundancies that help to minimize risk of failure. Emergency system in case of tracking or measurement defects
  - ix. Dynamic analysis and tests along with static coefficients based on the actual tracker configuration, stiffnesses and geometry



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- x. Aeroelastic instability analysis for the proposed tracker structure to show that the stow angle will not result in aeroelastic instability
- xi. Definition of tolerances, maximum terrain inclinations North-South, East-West
- b) Wind tunnel tests from a recognized wind expert institute (IITs / CSIR-SERC / CPP Wind Engineering / RWDI or equivalent).
- c) Independent Engineers Bankability review report from reputable agencies like Black and Veatch, DNV, IITs or other premier institutions/agencies.
- d) Structure design review document from any IIT civil/Structural certifying department, if required.

**7.0. WARRANTY**

- 7.1 25-years lifetime design (at least) considering local ambient conditions and in respect of all standards for the PV modules support structures and foundations
- 7.2 5 Years warranty starting with the Project Commercial Operation Date (COD) for the complete mounting structure including but not limited to the design, material, and installation of the tracker, substructure, power unit, piles, and foundations
- 7.3 25 years for corrosion protection.

**8.0. QUALITY CONTROL**

Bidder shall submit the MQAP, FAT and FQP for the Tracker system including MMS for Owner's Approval during detail Engineering.

**9.0. OPERATION AND MAINTENANCE REQUIREMENTS**

**9.1. Bidder shall annually carry out the following for the solar tracker system including MMS:**

- a) Integrity inspection.
- b) Labeling and identification
- c) Thermography Inspection
- d) Checking of correct operation
- e) Monitoring operation tests
- f) Mechanical lubrication if required.

**9.2. Bidder shall carry out the following semi-annually for the solar tracker system including MMS:**

- a) Visual inspection of the cabling system including cable terminals
- b) Mechanical visual inspection including a) galvanization coating, b) torque marks,
- c) slew drives, d) transmission shaft, e) rotation bearings.
- d) Measurement inspection
- e) Parameter checks
- f) Electrical protection system check and checking of correct operation including a) Grounding system, b) plugs, c) controllers, d) Antennas (if any), e) Wind Sensors.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- g) Retightening if required.
- h) General cleaning of the overall system

9.3. Bidder/Tracker manufacturer (if applicable) shall also perform the checks related to battery life annually and if required the replacement of battery / As per recommendation of OEM / Standard Industry Practice, whichever is earlier.

9.4. **Bidder shall check the following inspection during O&M:**

- a) Correctly mounted and fixed or, not.
- b) Fixation bolts in place with correct torque value
- c) Shall be perfectly sealed with no water filtration
- d) Check whether all cable properly connected, shall perform the pull test.
- e) No surface damage or, any corrosion
- f) DC Power switch and safety button –Ok or, not Ok.
- g) No natural or organic disturbing elements shall be present.

**10.0. DOCUMENTS / DRAWINGS REQUIRED**

The following drawings / details shall be furnished during detailed engineering. However, the specific design calculations shall be submitted during drawings approval.

- a) Design Basis Report
- b) Engineering report locating the tracker/MMS as per terrain and yield assessment for various combinations.
- c) Equipment Datasheet
- d) Tracker Installation Manual
- e) Operation and Maintenance manual.
- f) Warranty Certificate
- g) Compliance Certificates
- h) Company Credentials with Customer Testimonials.
- i) Typical tracker block array layout (AutoCAD)
- j) List of Special tools and tackles required
- k) Structural (MMS) General arrangement drawings (AutoCAD)
- l) Structural Fabrication/ Parts Drawings (AutoCAD)
- m) Erection Procedure GA for MMS (AutoCAD)
- n) BOM of MMS in Structural section wise pattern.
- o) Detailed BOM of the Structural materials & connection details
- p) Wind tunnel testing report & certifications
- q) Complete tracker control system details
- r) Study for Dynamic Amplification Factor.
- s) Aero Elastic Study
- t) Post galvanization repair procedure
- u) Standard Operation Procedure (SoP) for Tracker System
- v) Any execution procedure if required
- w) Communication network architecture & BOM.
- x) QA Plan for tracker system & MMS
- y) Check list for Tracker & MMS
- z) Block diagram



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- aa) List of inputs and outputs (I/O) by type (Digital, analog or Bus) for tracker system
- bb) Complete BOM and component level data sheets
- cc) Erection sequence drawings along with method of statement
- dd) Battery, motor, controller sizing criteria and life cycle assessment report
- ee) List of recommended spare part list
- ff) Grading analysis & levelling requirement of site as per Topo. Estimate of cut and fill quantity.
- gg) Pull Out Test Procedure
- hh) Post rejection procedure
- ii) Post head rectification procedure
- jj) Concrete Pile Procedure

Bidder shall provide the engineering support to locate the tracker/MMS as per site terrain & for yield assessment for various combinations.

**11.0. TECHNICAL PARAMETERS**

Sl. No.	Description	Data
<b>A</b>	<b>Manufacturer Details</b>	
1)	Product Origin / Manufactured Country for Tracker System (if applicable) including MMS	Bidder to Specify
<b>B</b>	<b>General</b>	
1)	Type / Application	Horizontal Single Axis Tracker (if applicable) with MMS
2)	Compliance to Standards	Bidder to Specify
3)	Module Make, Type & Wp	Bidder to Specify
4)	Module Configuration per tracker system	Bidder to Specify
5)	Length per table	Bidder to Specify
6)	No. of Modules in a Row or, per tracker	Bidder to Specify
7)	Tracker suitable for frame & Frameless modules mounting	Bidder to Specify
8)	Orientation of the Tracker	Bidder to Specify
9)	Orientation of the module on structure	Bidder to Specify
10)	Minimum ground clearance to module	Minimum as specified in specification and approved by OWNER.
11)	Maximum terrain slope tolerance	Bidder to specify
12)	Tracker follows terrain slope	Bidder to specify
<b>C</b>	<b>Structure (MMS)</b>	


**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

1)	Structure Material / Details	Minimum as specified in specification. A detail BOQ of complete tracker to be provided separately for Purchaser review/approval & shall be part of tracker contract.
2)	Leg/Vertical post	Designed for 25 years, Leg/ vertical post must be HDG as per standard as specified.
3)	Rafter / Torque Tubes	Bidder to Specify
4)	Purlins/Module mounting rail	Bidder to Specify
5)	Posts per MW	Bidder to Specify
6)	Connections	Only Bolted connection at site. All fasteners shall be HDG or SS shall meet corrosion category mentioned above.
7)	Cut & weld details (if any) in case required to be done at site	No welding & cut at site
8)	Design Basic Wind Speed (min.)	47 m/s or as per project site condition in relevant IS code (whichever is higher)
9)	Maximum wind speed withstand capability as per tested design of OEM in tracking mode & in stow position	Bidder to Specify
10)	Total structure weight per Tracker without PV module (excluding bottom leg below NGL)	Bidder to indicate
<b>D</b>	<b>Drive System</b>	
1)	Driving Type / drive mechanism of tracker	Bidder to Specify
2)	No of motors per tracker & details of motor	Bidder to Specify
3)	Motor type, rating, operating voltage & make	Bidder to Specify
4)	Bearing	Maintenance free, self- lubricated type
5)	Bearing material	Bidder to Specify
6)	Motor assembly mounting	Bidder to Specify
<b>E</b>	<b>Auxiliary Power</b>	
1)	Self-powered / external supply	Self-powered
2)	Daily energy consumption	Bidder to Specify, shall be <0.1% of mounted module capacity



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

3)	Power Supply with back-up battery	Bidder to Specify
4)	Type of battery	Bidder to Specify
5)	Whether BMS is available	Y / N (please tick)
6)	Ingress protection of enclosure on bearing	IP-55 or, better as per corrosion category
<b>F</b>	<b>Tracking Control System</b>	
1)	Tracker system operation temperature	Bidder to Specify
2)	Tracking Control Algorithm	GPS + Astronomical algorithm
3)	Tracking Range	To meet targeted generation
4)	Tracking Accuracy	<± 2°
5)	Sensors provided for wind safety	Required
6)	Torsional Limiter	Required
7)	Controller Box details	Bidder to Specify
8)	Controller box location	Outdoor and shall be suitable for ambient condition
9)	Controller box degree of ingress protection	IP-65 or, better
10)	Controller Details: Individual Tracker Controller Central / Group Controller	Bidder to Specify
11)	Control panel details: Mounting type & Other features	Free standing or tracker structure mounted Bidder to Indicate
12)	Communication system	Redundant (Wired/wireless) through meshed network topology
13)	Wireless communication requirement	Suitable for satisfactory operation at site condition. MODBUS TCP/IP hardwired output shall be provided in each Inverter Station.
14)	Power cabling requirement	Bidder to Specify
15)	Communication cabling requirement	Bidder to Specify
16)	Number of parameters logged by the data collector/list of parameters to be transmitted at each tracker or tracker block	Tracker position, motor current, battery voltage, Wind speed, calculated position of sun etc.
17)	Frequency of real time data transmission	Bidder to Specify
18)	Back-up Power system	Bidder to Specify
<b>G</b>	<b>Foundation</b>	
1)	Foundation type	Bidder to Specify suitable based on Geotechnical report.

VOLUME - II



**EPC PACKAGE WITH LAND FOR DEVELOPMENT OF  
UP TO 500 MW (AC) SOLAR PV PROJECT ANYWHERE IN  
THE STATE OF GUJARAT**

**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

PART – 2 (A)  
SHEET 23 of 96

2)	No. of Foundations per row / tracker	Bidder to indicate
<b>H</b>	<b>Grounding</b>	
1)	Grounding System	Self-grounded structure / Bidder to Specify
<b>I</b>	<b>Miscellaneous</b>	
1)	Routine Tests	Shall be as per approved QAP/ applicable Standards.
2)	Total Shipping Weight	Bidder to Specify


**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**
**A3 - STRING COMBINER BOX**
**1.0 String Combiner box**

The design, manufacture, and testing of String Combiner Box (SCB) shall be carried out as per latest applicable standards. The equipment shall be designed, engineered and manufactured to achieve high availability and reliability.

**2.0 Codes & Standards**

Codes	Description
IEC 61439-1 & 2	Low Voltage Switchgear
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 61643	Low-voltage surge protective devices
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
EN 50539-11/12	SPDs for specific application including DC- Requirement and tests for SPDs in PV application.
IEC 60664	Creepage distances and clearances
EN 60715	Chromated DIN Rail
UL 94 V	Fire Resistant/ flammability
UL 746C	UV Resistant
UL-SU 6703	Fuses
IEC 62208	Enclosure for low voltage switchgear and control assemblies.
IEC 60947-1	Low voltage switchgear and control gear assemblies part 1: General rules





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Codes	Description
IEC 60364-7-712	Requirements for special installations or locations- Solar PV power supply systems
EN 50539 part 11/12	Surge Protection

### 3.0 Design Criteria

- 3.1 The String Combiner Box (SCB) shall be of 1500V DC grade.
- 3.2 The enclosure material shall be of FRP material (Fire retardant), Self-extinguishing and Halogen free property. It shall be UV resistant suitable for outdoor application. The enclosure shall be dust proof, nonconductive type.
- 3.3 Minimum 3mm thickness to be provided for enclosure.
- 3.4 All the components to be mounted inside the junction box should be mounted on FRP or Bakelite sheet with a minimum thickness of 5mm.
- 3.5 SCB shall have IP66 Ingress protection and IK 10 Impact protection.
- 3.6 All live parts inside the combiner shall be insulated and shall withstand a DC test voltage of 3.8kV for 1 minute.
- 3.7 Enclosure shall be provided with hinged door.
- 3.8 Suitable space shall be ensured for workability and natural cooling. The SCB shall be designed in such a way that the heat is dissipated in a natural way through thermal conductivity of the enclosure.
- 3.9 Positive side fuse shall be mounted on fuse holders and negative shall be grounded.
- 3.10 Combiner box shall be decided during detailed engineering based on Plant SLD/Design and temperature rise calculation (without Y connector and with Y connector), the current rating of the fuses shall be calculated based on PV Module current rating considering bi-faciality factor (if applicable) and fuse factor of 1.56 in line with standard. DC disconnect DC On-load Isolator shall be sized accordingly, and fuse rating shall be calculated as per IEC guidelines.
- 3.11 Solar PV On-load Isolator shall be suitable for 1500Vdc operational voltage having minimum Insulation voltage of 1500 V dc, in true 2 pole on load shall be installed at output of the SCB to secure any intervention in the SCB or in the field as per IEC60947-3. The isolators shall be type tested to carry the nominal current at rated Voltage till ambient Temperature of 60Deg C without any de-ration, inside the String Combiner box. The Switching part shall necessarily contain reinforced break with an integrated magnetic arc-extinguishing system for the PV arc. The PV isolator need to positive break indication given through a position indication window. The PV Isolator terminals need to be silver plated and shall comply with IEC 60947-3 and tested for PV application. These shall withstand any PV current and should have no critical current.
- 3.12 String fuses shall be of gPV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards and fuse base shall comply with IEC 60269-1. String fuses should be so designed that it should protect the modules from reverse current overload. Fuses or Isolation Link shall be mounted in pull out type fuse



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- holders. Fuse holders shall be suitable for DIN rail mounting. PCB mounted fuses are not acceptable.
- 3.13 There should be minimum 10 mm gap between two fuses (Fuse Holders) minimum 10 mm gap between two fuses (fuse holders).
  - 3.14 String combiner box outgoing feeder shall be provided with isolator which shall disconnect both positive and negative sides simultaneously on output side.
  - 3.15 The combiner box shall be provided with surge protection device (SPD) of type I+II, with 40kA maximum lightning discharge current
  - 3.16 SCB shall have provision for earthing connection with copper cable to dedicated earthing pit.
  - 3.17 The DC input cables from string or Y-connector shall be connected with PV connector and not with cable gland.
  - 3.18 All cable entries shall be located on bottom side of the box to prevent any possibility of water ingress into the box. The output cable glands shall be double compression type metal glands of suitable size.
  - 3.19 All metallic hardware such as hinges, nuts, bolts, screws, washers etc. shall be of SS304 and appropriate size.
  - 3.20 Any other additional accessories as may be considered relevant and applicable for the operation and mounting of String Combiner Boxes shall be included in the scope.
  - 3.21 Canopy / shading arrangement shall be provided on top of String Combiner Box to avoid exposure to direct sunlight. Minimum 150 mm extension and SMB enclosure can be opened without obstruction with canopy
  - 3.22 Spare DC input terminals shall be provided in all SCBs. Total number of SCBs shall be calculated accordingly.
  - 3.23 System should be able to operate on error free and trouble-free mode, at 50°C ambient temperature (and internal combiner box temp of 70°C). Heat rise calculation to be submitted.
  - 3.24 The common collection bus bars should be made up of zinc/tin coated copper and shall be suitably sized to limit temperature rise within safe operating limits.
  - 3.25 All internal wiring shall be carried out with stranded copper wires with voltage rating mentioned elsewhere in the specification. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring.
  - 3.26 Complete assembled SCB shall be subject to heat run type test to be witnessed by owner after manufacturing. The heat run test to be carried out at 1.25 times the rated current i.e.  $1.25 \times (I_{mp} \text{ of PV Modules}) \times (\text{no. of string inputs} + \text{spare})$ . In case it is found that the temperature rise is beyond the acceptable limits, bidder shall redesign the assembly and perform the test free of cost to verify that temperature rise is within acceptable limit.
  - 3.27 Operating temperature of the components used in the enclosure shall not exceed OEM recommended temperature limit at ambient temperature of 50 deg C or as per CEA Guidelines / Working committee report whichever is higher for rated load conditions along with spare.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

3.28 Minimum ground clearance for String combiner box shall be 750mm from bottom of SCB.

**4.0 Technical Parameters**

Sl. No.	Item Description	Unit	Technical Requirement
<b>1.</b>	<b>General Requirements</b>		
a)	Installation	-	Outdoor
b)	Maximum system voltage	V	1500
c)	Operating temperature range	°C	-20 to +70
d)	Design Ambient Temperature	°C	As per CEA Guidelines / Working committee report
e)	SCB input side	-	Fuse on positive side
f)	SCB output side	-	As per Calculation considering 20% margin
g)	Mounting arrangement	-	Free standing
h)	Earthing Cable Termination	-	Bus Bar type 2mm thickness
i)	Surge Arrestor	-	Type I + II
<b>2.</b>	<b>Input Details</b>		
a)	Number of DC inputs (+ & - being one input)	Nos.	Decided during detailed engineering based on Plant SLD/Design
b)	Input cable size suitability	-	1C x 6 sq.mm Cu solar cable
c)	Fuse rating	A	1.56 times Isc of PV Modules for one string



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Technical Requirement
d)	No of Fuse per Input	No.	1
e)	Type of cable entry/support	-	PV Connector (MC4 type)
f)	Rated System Voltage	V DC	1500
g)	Max I/P Current per Y-connector	A	20 (Approx.)
<b>3.</b>	<b>Output Details</b>		
a)	Number of DC outputs (+ & – being one output)	Nos.	Fuses to be provided in positive and negative for each SCB
b)	Output cable size suitability	-	Al, Armored, XLPE cable. Sizing to be decided during DE as per sizing calculations.
c)	Output Connection Type	-	Bus Bar Type Spreaders
d)	Maximum permissible DC Current	-	Bidder to specify
e)	DC Disconnecter rating	A	As per Calculation considering 20% margin
f)	Protection class – Class-II or higher		
<b>4.</b>	<b>Enclosure details</b>		
a)	Enclosure properties	-	FRP
b)	Cover Type	-	FRP Enclosure with hinged door
c)	Degree of Protection	-	IP 66
d)	Colour	-	RAL 7035
e)	Over all Dimensions	mm	As per design requirement
f)	Weight	-	Bidder to specify



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Technical Requirement
g)	Gasket Material	-	Polyurethane
h)	Flammability rating	-	Bidder to specify
i)	Mechanical impact resistance	-	IK 10
j)	Door and Locking Arrangement	-	Hinged door with latch
k)	Type of cable entry	-	Bottom/ Glands – Heavy duty Double compression nickel plated brass glands
l)	Bus Bar Size/material	-	Copper
m)	Back plate thickness	mm	5 mm Bakelite
n)	Min installation height from bottom of SCB	mm	750
o)	Ventilation plugs	Nos.	As per design requirement

## 5.0 Tests

5.1 String combiner box should be IEC certified system and should have proven track record and working satisfactorily since last 5 years.

5.2 Bidder shall provide all the test reports / test certificates and compliance certificates during detailed engineering and before installation at site.

5.3 The following functional tests shall be carried out for SCBs:

- i. High Voltage Test (HV Test)
- ii. Insulation Resistance Test at 2.5 KV DC
- iii. Disconnecter Switch Function Test (On/Off Function)
- iv. Continuity Test (Circuit Continuity)
- v. Torque Test
- vi. Heat Run test

## 6.0 Data to be furnished by vendor after award of contract



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**6.1 Drawings / Documents for Approval:**

- i. Engineering schedule indicating list of drawings, documents, data, test certificates, manuals, etc. to be submitted by the Bidder together with dates of submissions and category of approval i.e., for approval or for reference.
- ii. GA & Cross-sectional drawings of each String Combiner Box.
- iii. Guaranteed Technical Particulars for String Combiner Boxes.
- iv. Bill of materials including make, technical specification, etc. for all equipment / accessories.
- v. Detailed cross-sectional drawings showing all relevant internal details of all equipment / accessories.
- vi. Drawing showing the terminal connection.
- vii. Detailed quality assurance plan.
- viii. Final test procedures (at shop as well as at site) and Test Set-Up.
- ix. Design calculations (wherever necessary) to prove adequacy of the equipment offered.
- x. Any other drawings/documents considered necessary.

**6.2 Drawings / Documents for Information:**

- i. All IEC Certifications
- ii. Type test (including temperature rise test) certificates valid for five years for all equipment / accessories being supplied under this contract.
- iii. Routine test certificates for all equipment/accessories being supplied under this contract.
- iv. Instruction manual containing detailed instructions for all erection, testing, operation and maintenance requirements.
- v. Catalogue numbers of all components which need to be replaced during the life of the equipment.
- vi. Detailed instructions for the installation, operation and maintenance of GIS and accessories.
- vii. Maintenance procedures including precautions to be taken during operation and maintenance work.
- viii. All detailed catalogues and literature of equipment supplied.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A4 - INVERTERS**

**1.0 Inverters**

- 1.1 The design, manufacture, delivery, factory testing and inspection, delivery to site, installation and test commissioning shall be carried out as per latest applicable standards. The equipment shall be designed, engineered, and manufactured to achieve high availability and reliability.
- 1.2 The supplier shall arrange all specialized equipment / services necessary for proper erection, commissioning, and performance testing of all items of the equipment covered under this contract. The cost of the same shall be included in the contract price.
- 1.3 All routine and acceptance tests at Factory and Site acceptance tests shall be conducted as part of the contract with prior notice to Purchaser.

**2.0 Codes & Standards**

<b>Codes</b>	<b>Description</b>
IEC 62446	Grid connected photovoltaic system
IEC 62548	Photovoltaic Arrays
IEC 61683 with EN50530	Efficiency measurements
IEC 62116 / IEEE 1547 / UL 1741 or equivalent BIS	Anti-Islanding
IEC 61000 -6-2/ 6-4	Electromagnetic compatibility (EMC) test
IEC 62109-1 and 2 / IEC 62103	Safety of power converter use in PV system
IEC 60068 2 (1, 2, 14, 30), IEC 60068 2 (6 & 2-27), IEC 62093	Environmental testing
IEC 61439-1 & 2	Short circuit
IEC 60051	Indicating instruments
IEC60529	Degree of protection
IEC 60146	Semiconductor converters



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Codes	Description
IEC 60255-5	Surge withstand capability test in accordance with
IEEE-519	Harmonic levels
As per relevant CERC regulations and Grid code as amended from time to time	Grid connectivity and Fault ride through compliance

### 3.0 Design Criteria

- 3.1 The Inverters shall be of 1500V DC grade.
- 3.2 Inverters shall be Central Inverter or String Inverter for the entire project of spreading over the blocks as per Plot Plan. The Bidder must study the land profile and provide best offers for the options. Bidder shall propose the block sizes in line with latest trends of MW scale project, so that the balance of system cost minimizes as well as maintain the reliability of performance
- 3.3 Bidder shall conduct detailed Grid compliance studies with Power Plant Controllers for solar project as per CEA technical standard for grid connectivity and latest guideline of SLDC first charging clearance. Bidder may refer latest FTC (First Time Charging) procedures. The grid compliance studies to be done in PSS/E and PSCAD as per GETCO/STU. PSCAD generic model of inverter to be used in study. Bidder to check the availability of PSSE and PSCAD generic model of Inverter during selection of respective Manufacturer. Bidder shall address all the queries of STU/SLDC/GETCO/RLDC with respect to reports and models are answered to their satisfaction.
- 3.4 Inverter shall be delivering/absorbing dynamically varying reactive power at POI at least up to 0.95pf lag & lead operation in a way which is conducive to maintain the POI voltage as close as possible to the nominal value. Any over-voltage arising within the GIPCL Solar Plant for complying with the above requirement, shall be taken care of by the bidder in designing of the project. Bidder shall submit QV and PQ curve of Inverter.
- 3.5 The generating station shall remain connected to the grid when voltage at the interconnection point on any or all phases dips up to the level depicted by the thick lines in the curve at Annexure-I of Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019. During the voltage dip, the supply of reactive power has first priority, while the supply of active power has second priority and the active power shall preferably be maintained during voltage





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

drops, provided, a reduction in active power within the plant's design specifications is acceptable and active power be restored to at least 90% of the pre-fault level within 1 sec of restoration of voltage.

- 3.6 The nominal / rated output power/Apparent Power (MVA) (including active and reactive power) of the Inverter at POI (Point of Interconnection at GETCO end) corresponding to the design ambient temperature of 50°C or as per CEA Guidelines / Working committee report whichever is higher shall be considered to arrive at required number of inverters for the plant / individual blocks. The Quantity of inverter shall be calculated based on the active and reactive power support at ambient temperature of 50 deg C and as per CEA Regulation on technical standard for connectivity to the grid and amendments. Bidder shall maintain 100% active power and required reactive power considering Power factor 0.95 lag to 0.95 lead at voltage 0.95 to 1.05 per unit, with CEA's design temperature and other parameters given in the regulations.
- 3.7 Busbar to be used for AC/DC termination in the inverter shall be copper busbar only
- 3.8 Single Core AC Cables (from IDT to inverter) on inverter side shall be terminated by multi diameter glanding system (Roxtec Comseal AISI 316 or equivalent make) including Tapping of Auxiliary transformer if any.
- 3.9 All AC and DC cables shall be terminated by Heavy duty long barrel Copper / Bimetallic Lugs as per system requirement. Further, DC cable entry shall be with Heavy duty double compression nickel plated Brass Glands.
- 3.10 Inverter shall be capable of meeting all the following grid code compliance in line with CEA grid code through dedicated Power plant controller.
- a) Active Power Control
  - b) Reactive power capability and control
  - c) Reactive power injection at the grid Connection Point during night time
  - d) Fault-ride-through (FRT) requirement
  - e) Start-Up Requirement
  - f) Power Quality
- 3.11 Inverters shall be capable of operating successfully with Bi-facial PV modules.
- 3.12 Inverters shall be equipped with totally un-manned auto synchronization and de-synchronization facility, so that during power generation mode the inverter shall automatically get synchronized with the network and during sleep mode will automatically isolate.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.13 The inverter output shall always follow the grid in terms of voltage and frequency and shall always remain synchronized with the grid. This shall be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.
- 3.14 The manufacturer shall ensure that the supplied inverter is capable of exporting power to the network during generation mode and shall desynchronize when the grid is not available, or the available solar insolation is insufficient.
- 3.15 The inverter output shall always follow the grid in terms of voltage and frequency and shall always remain synchronized with the grid.
- 3.16 This shall be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter.
- 3.17 Thus, control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.
- 3.18 Inverter grid synchronisation time shall be as less as possible or as per requirement of grid code / CEA / CERC/GETCO/SLDC and relevant statutory requirements.
- 3.19 The inverter shall be capable of adjusting its output voltage and frequency to suit the grid condition.
- 3.20 The Inverter MPPT range to be selected by manufacturer to comply the grid compliance requirements. Bidder to propose the number of MPPTs depending on the type of Inverter.
- 3.21 Maximum power point tracker (MPPT) shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism and make of MPPT shall be mentioned by the Bidder in the Bid. The MPPT must have provision for constant voltage operation. The MPPT unit shall confirm to IEC 62093 for design qualification.
- 3.22 The Inverter should have the option to expand the number of DC inputs with extension cabinets.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.23 DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs shall not be connected on the single input DC terminal of the inverter.
- 3.24 If adequate number of inputs are not available in the selected inverter by the Bidder, then a DC junction box with protection devices such as fuse DC disconnects and copper busbar with rated current carrying capacity may be incorporated into design. The Bidder has to indicate the selected parameters in the Bid.
- 3.25 The Inverter shall have provision for negative grounding. Inverter shall possess ground fault detector and interrupter function (GFDI). The fuses of the negative grounding system shall be as per UL 1741 standard.
- 3.26 Insulation monitoring system shall be provided according to IEC 62109-2.
- 3.27 The inverter shall be with minimum auxiliary power consumption on-duty & off-duty. The bidder is required to guarantee the auxiliary power consumption.
- 3.28 Incoming and outgoing connections to String inverter and its external components shall be through cables. Entry & exit of cables shall be from bottom of the cubicles. Suitable gland plates shall be provided.
- 3.29 Incoming connections to Central inverter and its external components shall be through cables, whereas connections between Central Inverter and Inverter duty Transformers shall be with suitably rated busduct or cables.
- 3.30 The inverter system shall be complete with necessary filters to limit the harmonic distortions to the load.
- 3.31 The Inverter shall have self-diagnostic software with analogue and digital I/O interface for control and monitoring.
- 3.32 The Inverter shall also have remote start and stop facility.
- 3.33 The inverters should retain the maximum efficiency at high temperatures.
- 3.34 The minimum European efficiency of the inverter shall not be less than 98% measured at 100% load as per IEC 61683 standards for measuring efficiency.
- 3.35 The Bidder shall specify the conversion efficiency of different loads i.e. 25%, 50%, 75% and 100% in the Bid. The Bidder should specify the overload inverter capacity in the Bid.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.36 The inverter power clipping shall be restricted to the extent possible to minimize the loss of power generation.
- 3.37 Proper cooling mechanism shall be adopted for the Inverter to maintain the temperature rise at an optimum level and mitigate the loss of generation due to high temperatures. No derating of output power till 50° C.
- 3.38 The DC input cable size that the inverter can accept, without any termination issues, shall be furnished by the Bidder.
- 3.39 The AC power output in case of Central Inverter shall with non-segregated phase busduct or cables of suitable size as per requirement with proper design margin.
- 3.40 Standalone UPS shall be provided to meet the auxiliary power requirement of inverter. It shall have a backup storage capacity as per CEA requirements. Maintenance free type batteries shall be provided for the UPS. If Outdoor inverters are provided, then the UPS shall also be suitable for outdoor duty with IP 55 or better ingress protection.
- 3.41 Inverter shall have inbuilt system for meeting its own auxiliary power requirement.
- 3.42 For inverter station Auxiliary power requirements can be tapped from inverter AC output terminals or from LV side of IDT with required protection on primary and secondary auxiliary transformer.
- 3.43 Inverters shall be selected with respect to the local climatic and environmental conditions and equipped to withstand high amounts of dust in the air and high temperatures.
- 3.44 Inverter shall be provided with zone monitoring as a part of the base offer. .
- 3.45 Inverter shall measure the Voltage, current and calculated power for each of its DC input.
- 3.46 Availability of individual inverter should be more than 98% and overall plant inverter availability shall not be less than 99.5%. Both the availability and up-time requirement shall be guaranteed by the manufacturer for 25 years.
- 3.47 In case of failing to achieve this due to failure of any component of inverter the Bidder shall either replace the inverter or the component at his own cost.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.48 DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs shall not be connected on the single input DC terminal of the inverter.
- 3.49 If adequate number of inputs are not available in the selected inverter by the Bidder then a DC junction box with protection devices such as fuse DC disconnects and copper busbar with rated current carrying capacity may be incorporated in to design. The Bidder has to indicate the selected parameters in the Bid.
- 3.50 Outdoor Central Inverter shall be installed on the platform, height of platform shall be such that cable bending radius, water logging not touch cable terminals, cooling is maintained and other relevant factors. The platform shall be covered by at least 60 cm extended canopy on all sides.
- 3.51 String Inverter shall be provided with extended canopy of atleast 15 cm on all side and height of String Inverter shall be based on cable bending radius, water logging not touch cable terminals, cooling is maintained and other relevant factors.
- 3.52 **Inverter Protection**
- 3.53 Inverter DC input side shall be provided with Motorized DC Isolator with fuse / MCCB along with Hall sensor (accuracy of 1.0 class or better) for each incoming DC cable from SMB and output side with AC Air circuit breaker.
- 3.54 Air circuit breaker shall be provided. The ACB as required can be provided as a part of Inverter or separately based on standard design and configuration of Inverter manufacturer. The ACB shall be able to withstand the maximum fault current for minimum one sec duration.
- 3.55 ACB shall be provided with electronic protection unit as per system requirement.
- 3.56 Since big Inverter two nos. of Motorized DC Isolator may be provided, so that in case of fault in any DC cable at least 50% generation shall not be affected.
- 3.57 The incoming DC feeder of inverter shall have suitably rated isolators to allow safe start-up and shut down of the system and its terminals should be shrouded. The DC feeder shall terminate in the fuse box through a suitable fuse rating. The fuse sizing calculation shall be furnished by Bidder during detail engineering. The fuse box shall have two spare terminals with fuse and holder for the future use. The connection between the fuse box and inverter shall be through copper bus bars only.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.58 The inverter shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of inverter component failure or from parameters beyond the inverter's safe operating range due to internal or external causes. Faults due to malfunctioning within the inverter, including commutation failure, shall be cleared by the inverter protective devices.
- 3.59 During low ambient temperature, output from PV Modules will be higher than at high ambient temperature. Suitable protection system shall be provided for the same.
- 3.60 The following minimum protections shall be provided for inverter:
- a) Reverse polarity
  - b) Reverse power
  - c) AC-DC Over-current
  - d) Overload protection
  - e) Earth fault protection (Alarm and Trip)
  - f) GFDI and PV Array insulation monitoring
  - g) Anti-Islanding feature
  - h) AC-DC Under / Overvoltage
  - i) Under / Over frequency
  - j) Surge protection (Type I +II)
  - k) Short circuit protection
  - l) Over temperature protection
  - m) Power regulation in the even of thermal overloading
  - n) Fault Ride through(LVRT and HVRT)
  - o) Surge protection for auxiliary and communication circuits
  - p) Cooling System failure protection Synchronization Loss Protection
  - q) Emergency Stop Button on Inverter front panel for tripping Inverter with complete DC and AC electrical isolation
- 3.61 The inverter shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line. The inverter shall also have the adequate protection against earth leakage faults.
- 3.62 Internal surge protection device (SPD) shall be provided in both the inverter on DC and AC side.
- 3.63 In case of grid failure, the inverter shall get desynchronized and re-synchronized with grid after revival of power supply. Bidder to furnish the time taken by inverter to re-synchronize after restoration of grid supply during detailed engineering.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

3.64 Inverter shall also confirm to IEC 62109 or equivalent international standard for compliance to requirement for the design and manufacture of inverter for protection against electric shock, energy, fire, mechanical and other hazards.

3.65 **Indications & Annunciation**

- a) The Inverter system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions.
- b) Local HMI / suitable display to be provided which shall indicate all the parameters listed below:
  - (i) Output Voltage
  - (ii) Output Current
  - (iii) Output frequency
  - (iv) Harmonics
  - (v) Power Factor
  - (vi) KW (output)
  - (vii) DC Input Voltage
  - (viii) DC Input Current
  - (ix) KW (input)
  - (x) KWH (Input)
  - (xi) Cooling fan failure
  - (xii) Grid monitoring

3.66 **Control & Monitoring**

- a) The Inverter control system shall be fully compatible for remote operation via communication link.
- b) Inverters shall have suitable communication card (Modbus TCP/IP or RS 485) for networking and SCADA integration and same shall support dual master communication. Inverters shall include all important measured and internal calculated analog values and alarm & trips signals for remote monitoring, storing and report generation purpose in SCADA system. Detailed list of above such parameters shall be provided along with their Modbus address during detailed engineering stage.
- c) Dedicated Prefab compartment required for Ethernet for networking
- d) Bidder shall indicate the type of communication protocol, supported by the Inverter along with the details of links provided for controlling from local control system and Power plant controller. The control system shall operate on windows or equivalent platform. The following minimum operating conditions shall be annunciated.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- (i) Inverter Failure
- (ii) Power stack over temperature
- (iii) Breaker/ Disconnect failure
- (iv) Over load
- (v) Over load shutdown
- (vi) Emergency shutdown
- (vii) DC Circuit breaker / switch open
- (viii) AC Main failure
- (ix) Fan failure
- (x) Asynchronous condition and synchronous condition
- (xi) Control power failure
- (xii) DC ground fault

e) The inverter shall also have following features:

- (i) Maximum loss in sleep mode shall be less than 0.05% of rated power.
- (ii) Set point pre-selection for Active power and VAR control.
- (iii) Unit wise and integrated data logging.
- (iv) Dedicated Ethernet for networking.
- (v) Protection against sync loss, over temperature, cooling system failure.
- (vi) Power regulation in the event of thermal overloading.
- (vii) Bus communication via interface for integration.
- (viii) Integrated protection in the DC and three phase system.
- (ix) Ground fault detector to sense discharge current with respect to ground.
- (x) Insulation monitoring System
- (xi) Self diagnostic software
- (xii) I/O interface for control and monitoring
- (xiii) Remote start and stop provision
- (xiv) Anti-Islanding protection
- (xv) The inverter should be self-managing and stable in operation. A self-diagnostic system check should occur on start-up. Functions should include a test of key parameters on start-up.
- (xvi) <3% of nominal power Harmonics

f) The inverter shall be capable to provide high resolution data ( $\leq 10$ ms accuracy) for at least 10 second period. The data shall be provided as per the format specified in Annexure-I(E)(c) of Draft Detailed procedure covering modalities for first time energization and integration of new or modified power system.

**3.67 Harmonics**



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Necessary input and output filters shall be provided for the inverter. Design shall be such that the harmonics injected back to the source and to the load shall be within limits specified in IEEE-519 at the point of interconnection of the Inverter to the system.

**3.68 General warranty & Service**

The minimum inverter guarantees given by the manufacturer shall be include Workmanship guarantee: product guarantee against manufacturing defects for a minimum period of 5 years after Actual Facility Date. Extended warranty of 25 years shall be provided.

**3.69 Power plant Controller**

Power plant controller (PPC) for meeting CEA grid connectivity shall be a dynamic system that will control the PV Inverters to fulfill the Grid utility requirements regarding the active and reactive power control.

PPC shall be designed to get a fast and accurate response at the point of connections of the PV Plant according to the set-points received from the grid authority.

The main features of the PPC shall be as follows:

- a) Reactive Power operating modes
  - Voltage control
  - Power factor control
  - Constant Reactive power control
  - Reactive power control for low power and power factor control for high power
- b) Active Power operating modes
  - Active Power curtailments
  - Ramp rate control
  - Frequency control

**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**
**4.0 Technical Parameters**

Sl. No.	Item Description	Unit	Technical requirement
1.	Inverter type	-	String/Central
2.	Installation	-	(Outdoor / PV Station container)
3.	Switching devices	-	IGBT
4.	Control	-	Microprocessor / DSP
5.	Maximum DC input voltage	V	1500
6.	MPPT Voltage range	V	To be selected by Vendor
7.	Number of MPPT		Single MPPT or Multi-MPPT
8.	Output Frequency	Hz	50
9.	Design ambient temperature without derating	°C	50
10.	Operating temperature	°C	0 - 60
11.	Number of SCB/DC inputs	No.	The number of inputs shall be decided based on layout requirement
12.	Input DC fuse box	-	Integrated
13.	Operating power factor range of Inverter	-	0.8 lead to 0.8 lag
14.	Maximum permissible DC:AC ratio at 50°C	-	1.5
15.	Maximum/peak efficiency, European Efficiency	%	98.0 (minimum) / As per IEC 61683



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Technical requirement
16.	European Efficiency		As per IEC 61683
17.	Degree of protection	-	IP 54 or better for containerised solution and IP 65 or better for direct outdoor
18.	Surge protection (AC and DC)	-	Type I + II
19.	Grid support	-	Compliance to CEA (Technical standards for connectivity to grid and amendments)
20.	Dynamic Active and Reactive power control	-	Required
21.	Power Plant Controller	-	Bidder to decide the requirement for meeting CEA requirement
22.	Reactive power support during night-time at the grid connection point	-	Required
23.	Maximum total harmonic distortion	%	<3% at nominal power
24.	DC Injection		<0.5% of rated current
25.	Flicker		As per CEA Regulation
26.	System availability	%	99.0~99.5
27.	Noise / acoustic level	dB	< 75 dB (A) at 1 m
28.	Zone Level Monitoring	-	To be provided
29.	Visual Display	-	Colour LCD/LED display with touchscreen
30.	SCADA Interface	-	RS 485 or TCP-IP



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Technical requirement
31.	Nominal AC output voltage	-	As per design requirement
32.	Humidity	-	95 % non-condensing
33.	Anti PID	-	Required

### 5.0 Inverter Data required for system study

- a) Make
- b) Model Name
- c) Type of Inverter (MW @ Temp)
- d) Data Sheet
- e) PSSE manual shall be available in English along with OEM model
- f) PSSE Generic model shall be compatible with version 34\*.dyr FILE OF THE INVERTER
- g) Site measurement report / validation report for inverter model
- h) Power quality test report (DC Injection and Flicker) as per CEA guideline
- i) CEA test report (LVRT/HVRT field test results of actual inverter at site)
- j) Harmonic test (current) report with 10% increment in active power starting from 0% upto 100% of rated power
- k) Capability Curve for various temperature (from 35-51 deg C)
- l) Inverter short circuit modelling of Renewable Sources in line with NCSFC (non-conventional source fault current) modelling and Voltage droop characteristics
- m) Protection settings of the inverter in \*.dyr file as CEA Guidelines.
- n) Block diagram of the inverter controller {controller transfer function (can be obtained from inverter manufacturer)} with suitable parameter sets and the technical documentation
- o) Inverter benchmarking report (actual model with psse and pscad model) if inverter benchmarking report is done with psse udm model, one to one comparison and mapping between psse udm & generic model should be provided.

Sr No	PSCAD/ PSSE CHECKLIST	OEM response (confirm)
<b>PSCAD Inverter OEM Checklist</b>		
1	PSCAD model version 5.0.1, 64-bit, Intel Fortran XE 15.0.7.287 and above compatible	-
2	Inverter should be a one module and also allow the multiple instances of the module.	-
3	Tripping flags shall be provided inside the PSCAD model	-
4	PSCAD manual shall be available in English along with OEM model	-
<b>PSCAD PPC OEM Checklist</b>		
1	PSCAD model version 5.0.1, 64-bit, Intel Fortran 15 and above compatible with control modes (V control, Q control, PF control)	-



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

2	PSCAD manual shall be available in English along with OEM model	-
3	OEM to confirm if one PPC can control multiple plants	-
<b>PSSE Inverter OEM Checklist</b>		
1	PSSE Generic model shall be compatible with verison 34	-
2	During HVRT, inverter shall absorb reactive power in line with CEA guidelines*	-
3	Inverter short circuit modelling of Renewable Sources in line with NCSFC (non-conventional source fault current) modelling and Voltage droop characteristics	-
4	PSSE manual shall be available in English along with OEM model	-
<b>PSSE PPC OEM Checklist</b>		
1	PSSE Generic model shall be compatible with verison 34	-
2	PSSE manual shall be available in English along with OEM model	-
<b>PSSE Checklist for Inverter Capability Curve</b>		
1	Capability Curve for site specific temperature	-
2	Capability Curve for various temperature (from 35-50 deg C for each degree temp)	-
<b>PSCAD/PSSE Common Checklist</b>		
1	Inverter operating voltage should be in line with transformer secondary voltage indicated in project SLD	-
2	PSCAD/PSSE benchmarking report (with PSSE generic model) shall be made available with OEM models	-
3	Protection settings in the manual should be in line with PSCAD/PSSE model	-
4	Voltage and frequency protection settings shall be same in both PSCAD and PSSE models and in line with CEA guidelines*	-
5	During HVRT, inverter shall absorb reactive power in line with CEA guidelines*	-
6	Inverter operating voltage should be in line with transformer secondary voltage indicated in project SLD	-
<b>Inverter Test Reports as per CEA guideline</b>		
1	Power quality test report (DC Injection and Flicker) as per CEA guideline	-
2	Harmonic test (current) report with 10% increment in active power starting from 0% upto 100% of rated power	-
3	CEA test report (LVRT/HVRT field test results of actual inverter at site)	-
<p><b>As per CEA and working group committee guidelines, July 2022. Note: OEM shall confirm compliance of all above points, after which Siemens shall consider integrating the OEM model into the plant model</b></p>		



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**6.0 Drawing/Models/Documents/Compliances for First time charging**

The submitted details shall be as per CEA technical standard for grid connectivity and latest guideline of RLDC first charging clearance. In this regard, bidder shall provide all technical details including Inverter bench marking report, Generic model data of Inverters, suitable for use in PSS/E and PSCAD software available at RLDC and Encrypted user-defined model (UDM)/generic model of Inverter in PSS/E software (\*.dll files) as applicable. Provision of PSCAD model of inverter shall also be in bidder scope. In case any site testing required for grid compliance as per RLDC, it shall also be conducted.

- a) Make
- b) Model name
- c) Capacity of inverter (MW/MVA/MVAR @ temp)
- d) Type of inverter (central/ string)
- e) Datasheet
- f) PSSE manual shall be available in English along with OEM model
- g) PSSE Generic model shall be compatible with version 34
- h) \*.dyr FILE OF THE INVERTER
- i) Site measurement report / validation report for inverter model
- j) Power quality test report (dc injection and flicker) as per cea guideline
- k) Cea test report (lvrt/hvrt field test results of actual inverter at site)
- l) Harmonic test (current) report with 10% increment in active power starting from 0% up to 100% of rated power
- m) Capability curve for various temperature (from 35-51 deg c)
- n) Inverter short circuit modelling of renewable sources in line with ncsfc (non-conventional source fault current) modelling and voltage droop characteristics
- o) Protection settings of the inverter in \*.dyr file as cea guidelines.
- p) Block diagram of the inverter controller {controller transfer function (can be obtained from inverter manufacturer)} with suitable parameter sets and the technical documentation
- q) Inverter benchmarking report (actual model with psse and pscad model)
- r) If inverter benchmarking report is done with psse udm model, one to one comparison and mapping between psse udm & generic model should be provided.

**7.0 Tests**

7.1 Following minimum tests shall be performed as routine tests on the Inverter as per IEC 62109, IEC 61727, IEC 62116, IEC 61683, IEC 60068, IEC 61000 and other relevant standards:

- a) Main circuit HV test and IR test.
- b) Main circuit IR test after performing HV test



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- c) Automatic Start/Stop with grid
- d) Inverter efficiency
- e) Grid-connection current harmonics at different loads
- f) MPP Tracker test
- g) Power factor measurement at different load
- h) Output power control
- i) Manual Start/Stop
- j) Anti-Islanding protection test
- k) Grid-connection recovery test
- l) AC Over/under-voltage protection
- m) Over/under-frequency protection
- n) DC over voltage protection
- o) Circuit breaker operation test
- p) Cabinet and mechanical structure quality
- q) Protection functions check
- r) Synchronization test
- s) Auxiliary power consumption at various load
- t) Fan on/off and direction of rotation check
- u) Degree of protection
- v) LCD Display panel check
- w) Functional test on communication circuit
- x) Heat run test-on one unit per Lot offered for Inspection. Heat run test shall be carried out for inverter system at rated load under relevant ambient conditions.
- y) Load test in steps of 10%, 20%, 30%, 50%, 75% and 100% loads.
- z) Noise level test

7.2 The following Test Reports for the supplied Inverter shall be furnished:

- a) LVRT and HVRT test report
- b) Flicker test report
- c) Harmonic test report
- d) Short circuit type test report
- e) Max and Min Continuous Voltage Operation Test Report
- f) Active Power Ramp Up Test Report

7.3 Apart from the above mentioned, tests which are necessary as per standard requirement shall be performed by the vendor. Test certificates for all components used in the inverter shall be furnished. All the instruments used shall have valid calibration certificates.

7.4 The following checks shall be performed on Inverter:



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- a) Check correct installation
- b) Check correct operation of the power-on and of the warning lights
- c) Check correct connection to the strings and the electrical panels
- d) Check about the correct operation of the conditioning or ventilation system
- e) Confirm integrity of the electrical cabins
- f) Check all tags and labels are correct

**8.0 Data to be furnished by vendor after award of contract**

**8.1 Drawings / Documents for Approval:**

- i. Document specifying product technical information along with datasheet
- ii. Valid test certificates not older than 5 years
- iii. Quality assurance plan, FAT/SAT procedure
- iv. Field Quality Plan
- v. Methodology and write-up on the Grid support provided by the Inverter at the point of interconnection
- vi. Methodology and write-up on the Active and reactive power support provided by the Inverter at the point of interconnection
- vii. Methodology and write-up on the Reactive power support at night time provided by the Inverter at the point of interconnection
- viii. Product warranty document
- ix. Schedule of manufacturing and delivery

**8.2 Drawings / Documents for information:**

- i. Installation manual
- ii. Inverter data sheets, reactive power capability diagram (P-Q characteristic), mathematical models of inverter control system.
- iii. Harmonic spectrum of the inverters for harmonic analysis.
- iv. Recommended spare parts list for 5 years
- v. Printed instructions to receive, store and handle the Inverter at site
- vi. Inverter data required for system study





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A5 - SOLAR CABLES**

**1.0 Solar Cables**

Cables for interconnection between PV modules and string combiner box shall be of suitable voltage grade to suit the maximum output voltage applicable. The DC design voltage for this project is 1500V. The design and engineering shall make use of most recent international standards and best design practices.

**2.0 Codes & Standards**

<b>Codes</b>	<b>Description</b>
BS EN 50618	Electrical Cables for Photovoltaic system
EN 50619:2014/IS17293:2020	DC cable for Photovoltaic system
BS EN 60228	Standard for Copper Conductor
IEC 60332-1	Fire performance
IEC 60287	Electric cables – Calculation of the current rating
IEC 60216	Temperature index and service life of over 20 years
IEC 60754-1	Halogen free
IEC 60811	Resistant to chemicals and oils
IEC 62548	Photovoltaic (PV) arrays – Design requirements

**3.0 Design Criteria**

The cables between the PV modules end to combiner box shall have the following specific requirements:

- 3.1 All cables shall conform to the requirements of the following standards and codes EN 50618, 50619:2014/IS17293:2020
- 3.2 All cables shall be flame retardant, low smoke minimum FRLS or as per CEA regulation, UV protected type designed to withstand all mechanical, electrical, and thermal stresses developed under steady state and transient operating conditions.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.3 Conductors shall be electrolytic grade high conductivity annealed tinned copper. Conductors shall be multi-stranded, smooth, uniform in quality and free from scale and other defects.
- 3.4 Cables shall be of solar grade and have insulation, inner sheath and outer sheath shall be of high-grade cross-linked compound as per EN 50618.
- 3.5 Cable employed for series connection of PV modules through MC4 connectors shall be of 4 or 6 sq mm size. 6 sq.mm cable to be used for Y-connector configuration. For conductor size positive tolerance is only allowed.
- 3.6 The DC cabling up to Inverter shall be designed such that the average DC ohmic power loss at STC loss does not exceed 1.5%.
- 3.7 The outer sheath colour of DC cable shall be black and black with red stripe. The ratio of black and black with red stripe cable shall be 50:50. All Positive terminals of PV module shall be black with red stripe cable and all negative terminals of PV module shall be connected with black coloured cable.
- 3.8 Cables used for inter-connecting SPV modules as well as Modules to SCB's shall conform to the requirements of EN 50619:2014/IS17293:2020 applicable for DC cable for photovoltaic system.
- 3.9 The cables shall be laid in HDPE conduits. The HDPE conduit fill factor shall be restricted to 50%.
- 3.10 No joints in cable shall be allowed between terminating points i.e cables from solar PV module to SMB/SCB.
- 3.11 DC Cable shall have Lifetime reliability lasts up to 25 years even under tough external conditions.
- 3.12 The cables specifications / design shall be suitably selected as per laying final philosophy/ methodology decided during detail engineering by the Bidder considering the site environmental conditions etc. Bidder shall submit the final specification with methodology for Owner's Approval. All DC cable shall be fully recyclable in accordance with new environmental regulations.
- 3.13 In addition to manufacturer's identification on cables as per EN50618/IS 17293, following marking shall also be provided over outer sheath.
- a) Cable size, voltage grade and code designation "PV"
  - b) Word FRLS /Actual specification
  - c) Sequential marking of length of the cable
  - d) GIPCL
- 3.14 The distance between two consecutive printing, identification or embossing shall not be more than 550 mm. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

#### 4.0 Technical Parameters

Sl. No.	Item Description	Unit	Data
	<b>GENERAL</b>		
1.	Cable Size	Sq.mm	4 or 6. Sq.mm (positive tolerance only) 6 sq.mm cable to be used for Y-connector configuration.
2.	No. of cores	Nos.	1
3.	Specification/Construction	-	BS EN 50618
4.	Rated Voltage	Vdc	1500 V
5.	U0/U	kV	1.5/1.8
6.	AC Test voltage	kV	6.5
7.	Max Permitted DC Voltage	V	1800 V DC
8.	Temperature Range		
9.	a) Ambient Temperature	°C	-40°C to +90°C
10.	b) Max Temperature at Conductor	°C	120°C
11.	c) Short Circuit Temperature for 5 sec.	°C	250 °C as per BS EN 50618
12.	Conductor		
	a) Material	-	Annealed tinned Copper (as per EN 60228)
	b) Flexibility class	-	Class-5 (as per EN 60228)
13.	Insulation		



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Data
	a) Material	-	Polyolefin Copolymer electron-beam cross linked (XLPO)
	b) Nominal thickness	mm	0.7
14.	Outer Sheath		
	a) Material	-	Polyolefin Copolymer electron-beam cross linked (XLPO) with anti-termite and anti-rodent
	b) Minimum thickness of sheath (with tolerance)	mm	0.8
15.	Nominal Overall Diameter (with tolerance)	mm	As per manufacturer
16.	Required Properties		
	a) Weathering / UV resistance	-	As per BS EN 56018 (Annex E)
	b) Flame retardant	-	As per EN 60332-1-2:2004
	c) Halogen free	-	As per EN 50525-1:2011
	d) Ozone resistant	-	As per EN 50396:2005 (Annex B)
	e) Acid and alkaline resistance	-	As per EN 60811-2-1
	f) DC cable for Photovoltaic system		EN 50619:2014/IS17293:2020
17.	Colour Coding	-	The ratio of black and black with red stripe cable shall be 50:50
18.	Drum		



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Item Description	Unit	Data
	a) Type	-	Steel
	b) Packing length (along with tolerance)	M	As per manufacturer (only positive tolerance allowed)
19.	Sequential Marking on the cable	-	Required
20.	Type of end sealing	-	Required

### 5.0 Tests

SL. NO.	Description
1.	Electrical tests
	a) Measurement of the resistance of conductor
	b) Voltage test on completed cable with AC or DC
	c) Check for absence of faults on the insulation
	d) Measurement of insulation resistance
	e) Long term resistance of insulation to DC
	f) Surface resistance of sheath
2.	Constructional and dimensional tests
	a) Conductor
	b) Insulation
	c) Sheath
	d) Ovality
	e) Sheath colour
	f) Sheath marking
3.	Insulation material test
4.	Sheath material test
5.	Compatibility test
6.	Cold impact test



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

SL. NO.	Description
7.	Cold bending test
8.	Cold elongation test
9.	Ozone resistance on complete cable
10.	UV Resistance Check
11.	Dynamic penetration test
12.	Damp heat test
13.	Shrinkage test on sheath
14.	Test for vertical flame propagation on complete cable
15.	Smoke emission of complete cable
16.	Assessment of halogens for all non-metallic materials

**6.0 Data to be furnished by vendor after award of contract**

**6.1 Drawings / Documents for Approval:**

- i. Cross section of all cables.
- ii. QAP for all cables.
- iii. Technical specification & GTP, etc. for all cables.
- iv. Final test procedures (at shop as well as at site) and Test Set-Up.
- v. Design calculations (wherever necessary) to prove the adequacy of the equipment offered.
- vi. Any other drawings/documents considered necessary.

**6.2 Drawings / Documents for information:**

- i. Continuous current rating of the cable
- ii. General technical data
- iii. Construction details including type of material used and thickness of each material for each type of cable in a tabular form.
- iv. Instruction Manuals

VOLUME - II



**EPC PACKAGE WITH LAND FOR DEVELOPMENT OF  
UP TO 500 MW (AC) SOLAR PV PROJECT ANYWHERE IN  
THE STATE OF GUJARAT**

PART – 2 (A)  
SHEET 55 of 96

**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- v. Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/FS cables in line with applicable standard.
- vi. All detailed catalogues and literature of Cables supplied.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A6 - SCB TO INVERTER CABLE (1.9/3.3 KV)**

**1.0 SCB to Inverter Cable (1.9/3.3 kV)**

1.9/3.3kV Power cables shall be provided from string combiner box up to the Inverter. The design and engineering shall as per latest Indian standards or IEC standards.

**2.0 Codes & Standards**

<b>Codes</b>	<b>Description</b>
IS 7098	Cross linked polyethylene insulated PVC sheathed cable for (Part - II) working voltage from 3.3KV up to & including 33 KV
IEC 60502	Power cables with extruded insulation and their accessories
IS 3961/ IEC 60287	Recommended current ratings for cables
IS 3975	Low Carbon Galvanized steel wires formed wires and tapes for armouring of cables.
IS 5831	PVC insulation and sheath of electrical cables.
IS 8130	Conductors for insulated electrical cables and flexible cords.
IS 10810	Methods of tests for cables.

**3.0 General and Installation Requirements**

- 3.1 The cable shall be 1.9/3.3kV Grade, high conductivity stranded compacted circular aluminium conductor, single core, XLPE insulated, Inner PVC ST2 sheathed, galvanized steel strip armoured with overall separate extruded minimum FRLS or as per CEA regulation PVC ST2 outer sheath, conforming generally to IS:7098 (part-II)-1985 and its latest amendment thereof.
- 3.2 The insulation of each core and outer and inner sheath, shall comply with the IS: 5831. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.3 The sheath shall be suitable to withstand the operating conditions and the desired temperature rating of the cable. It shall be of adequate thickness, consistent quality and free from all defects.
- 3.4 Armouring shall be hot dip galvanized steel strip for DC application cables, whereas the same shall be of aluminium for AC application cables. The dimensions of armour shall be as per table 4 of IS:7098 (Part-II)/1985 and its latest amendment and strip shall conform to latest provisions of IS: 3975 -1988 and amendment thereof.
- 3.5 Extruded PVC outer sheath of type ST-2 as per IS: 5831/1984 and its latest amendment shall be applied over armouring with suitable additive to prevent attack by rodent and termite and its thickness shall be in accordance with clause -17.32 of IS:7098 (Part-III)/1985 and latest amendment thereof.
- 3.6 The nominal diameter of the armour shall be as the fictitious diameter under the armour according to IEC 60502-1.
- 3.7 All materials used in the manufacture of cable shall be new, unused and of finest quality. All materials shall comply with the applicable provisions of the tests of the specification, IS, Indian Electricity Rules, Indian Elect. Act and any other applicable statutory provisions, rules and regulations.
- 3.8 The PVC material used in the manufacture of cable shall be of reputed make. No recycling of the PVC is permitted. The purchaser reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that manufacturer is complying with quality control.
- 3.9 Short circuit ratings of various sizes cable calculated for duration of one second at maximum temperature of 250° C.
- 3.10 The cables shall be suitable for being installed directly in the ground, in the pipes or in the cable trays/trenches. The cables shall therefore be suitable for satisfactory operation under the tropical climatic conditions listed in the relevant clause.
- 3.11 No cable joint to join two cable ends shall be accepted except if single cable length as per OEM does not meet the requirement.
- 3.12 Weather proof Double compression type Cable glands made of heavy-duty brass machine finished and nickel chrome plated shall be provided for cable glanding, Thickness of plating shall not be less than 10 micron.
- 3.13 All Cable lugs shall be Heavy duty long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.
- 3.14 Cable installations shall be as per latest IS 1255.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.15 Bidder shall take special care in designing cable routing from SCB to inverter station to avoid bunching/overcrowding and derating of cables.
- 3.16 The cables specifications / design shall be suitably selected as per laying final philosophy/ methodology decided during detail engineering by the Bidder considering the site environmental conditions etc. Bidder shall submit the final specification with methodology for Owner's Approval
- 3.17 Color of the outer sheath shall be black for negative pole and red for positive pole.
- 3.18 In addition to manufacturer's identification on cables as per EN50618/IS 17293, following marking shall also be provided over outer sheath.
- a) Cable size, voltage grade and code designation "PV"
  - b) Word ' FRLS/Actual specification'
  - c) Sequential marking of length of the cable
  - d) GIPCL
- 3.19 The distance between two consecutive printing, identification or embossing shall not be more than 550 mm. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible. Other specification shall be in line with LT cable section.

#### **4.0 Design Criteria**

DC power cables shall be sized based on current carrying capacity, short circuit rating and permissible power loss as per specified under relevant performance guarantee clauses. The DC cabling up to Inverter shall be designed such that the average DC ohmic power loss at STC does not exceed 1.5%.

##### **4.1 Current carrying capacity:**

The cable shall be able to carry the full load current of the circuit continuously under the specified ambient temperature and other conditions of installation. For this purpose, suitable de-rating factors shall be considered due to:

- (a) Thermal resistivity of soil.
- (b) Ambient ground / Air temperature.
- (c) De-rating factor for grouping of cables over the current ratings at normal conditions given in standards. The design ambient temperature for this plant shall be considered as 50°C or as per CEA Guidelines / Working committee report whichever is higher.

##### **4.2 Permissible power loss:**

DC power loss shall be limited such that overall plant DC ohmic loss shall be within permissible limit as specified under relevant performance guarantee clauses.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**5.0 Technical Parameters**

Sl. No.	Description	Unit	Technical Requirements	
1.0	General requirements			
1.1	Voltage Grade	kV	1.9/3.3 kV	
1.2	Core	-	Single	
1.3	System Details			
	a) Nominal Power System Voltage	kV	1.5	
	b) Maximum System Voltage	kV	1.8	
	c) System Neutral Earthing	-	Not Applicable as used for DC system	
1.4	Design Ambient Temperature	°C	50 or as per CEA Guidelines / working committee report	
2.0	Conductor Material	-	Aluminium H2 grade as per IS 8130-1984	
	a) Flexibility Class	-	Class 2	
	b) Shape of conductor	-	Stranded & compacted	
3.0	Cable Size	-	As per cable sizing requirement, only positive tolerance is allowed	
4.0	Insulation	-	Extruded XLPE	
5.0	Insulation thickness	mm	2.0	
6.0	Temperature Range (as per IEC 60502-2) / IS 7098 part-2)			
	a) Maximum operating temperature at rated current	°C	90	
	b) Short Circuit Temperature for 1 sec.	°C	250	
7.0	Armouring	-	<b>For AC application</b>	<b>For DC application</b>
			Aluminium	Hot dip galvanized steel



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Unit	Technical Requirements
8.0	Outer Sheath	-	Minimum FRLS PVC Compound (ST-2) or as per CEA regulation
9.0	Colour Code	-	Colour of the outer sheath shall be black for negative pole and red for positive pole
10.0	Packing length with tolerance	-	No negative Tolerance
11.0	Sequential Marking on the cable	-	Manufacturer name, voltage grade, Size of cable, Type of cable and Year of manufacture at every one-meter interval
12.0	Seismic Acceleration		0.36g
13.0	End sealing	-	Required

### 6.0 Tests

Sl. No.	Description	Technical Requirements
1.0	Routine tests	
	a) Electrical resistance of conductors	As per IEC 60228/ IS 7098-2
	b) Partial Discharge test	As per IEC 60885-3/ IS 7098-2
	c) Voltage test	As per IEC 60502-2/ IS 7098-2
	d) Overall Diameter test	As per IEC 60502-2 / IS 7098- 2
2.0	Sample tests	As per IEC 60502-2 / IS 7098- 2
3.0	Type tests	
	a) Bending test	As per IEC 60502-2 / IS 7098-2 / IS 10810
	b) Partial Discharge test	
	c) Tan $\delta$ measurement for cables	
	d) Heat cycle test	As per IEC 60502-2 / IS 7098-2 / IS 10810
	e) Impulse test followed by a voltage test	
	f) Voltage test for 4 h	


**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Technical Requirements
	g) Impulse test	As per IEC 60502-2 / IS 7098- 2 / IS 10810
	h) Insulation resistance measurement at maximum conductor temperature	As per IEC 60502-2/ IS 7098- 2 / IS 10810
4.0	Type tests, non-Electrical	
	a) Measurement of thickness of insulation	As per IEC 60811-1-1 / IS 7098- 2 / IS 10810
	b) Measurement of thickness of non-metallic sheaths	As per IEC 60811-1-1 / IS 7098- 2 / IS 10810
	c) Tests for determining the mechanical properties of insulation before and after ageing	As per IEC 60811-1-2 / IS 7098- 2 / IS 10810
	d) Tests for determining the mechanical properties of non-metallic sheaths before and after ageing	As per IEC 60811-1-1 / IS 7098- 2 / IS 10810
	e) Additional ageing test on pieces of completed cables	As per IEC 60811-1-2/ IS 7098- 2 / IS 10810
	f) Loss of mass test on PVC sheaths of type ST2	As per IEC 60811-3-2 / IS 7098- 2/ IS 10810
	g) Pressure test at high temperature on insulations and non-metallic sheaths	As per IEC 60811-3-1 / IS 7098- 2 / IS 10810
	h) Test on PVC insulation and sheaths at low temperatures	As per IEC 60811-1-4/ IS 7098- 2 / IS 10810
	i) Test for resistance of PVC insulation and sheaths to cracking (heat shock test)	As per IEC 60811-3-1 / IS 7098- 2
	j) Water absorption test on insulation	As per IEC 60811-1-3 / IS 7098- 2
	k) Shrinkage test for XLPE insulation	As per IEC 60811-1-3 / IS 7098- 2
	l) Thermal stability test for PVC insulation	As per IEC 60811-3-2 / IS 7098- 2



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Technical Requirements
	m) Flame spread test on single cables	IEC 60332-1-2 / IS 7098- 2
	n) Shrinkage test for PE over sheaths	As per IEC 60811-1-3 / IS 7098- 2

**7.0 Data to be furnished by vendor after award of contract**

**7.1 Drawings / Documents for Approval:**

- a) Completely filled-in Data Sheets and Schedules.
- b) Technical particulars of cable cross sectional drawing, QA Plan and technical catalogues.
- c) Estimated weight of cables and cable drums.
- d) Experience list where cables of similar rating and sizes have been installed and are in satisfactory operation.
- e) Type test certificates/reports for the equipment covered in the specification issued by a National or International Testing Authority.
- f) Any other drawings/documents considered necessary

**7.2 Drawings / Documents for information:**

- a) Continuous current rating of the cable
- b) Cable current ratings for different types of installation, inclusive of de-rating factors for ambient temperature, grouping etc. Construction details including type of material used and thickness of each material for each type of cable in a tabular form.
- c) Instruction Manuals
- d) Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/FS cables in line with applicable standard.
- e) All detailed catalogues and literature of Cables supplied.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A7 – MODULE CLEANING SYSTEM**

**TECHNICAL SPECIFICATION FOR MODULE CLEANING SYSTEM (MCS)**

**1.0. SCOPE**

The purpose of this section is to describe technical details for Design, Construction, Supply, transportation, Installation, and commissioning along with mandatory training of O&M personnel about MCS for Photovoltaic solar power plant as per details given below. The design and engineering shall make use of most recent international standards and best design practices.

**2.0. PROPOSED CLEANING SYSTEM**

The Bidder Shall Install both Permanent Fresh Water based Wet cleaning system and Robotic Cleaning systems.

**3.0. DESIGN CONSIDERATION AND GENERAL SYSTEM REQUIREMENTS FOR WET CLEANING SYSTEM**

- 3.1 Bidder shall lay the piping system for the Module cleaning system and also make arrangement for water supply and storage.
- 3.2 Permanent arrangement shall be made by Bidder for Module cleaning system comprises HDPE Piping network, Pumps & Motors, FRP Tanks, & all other equipment/ materials/ arrangements required to complete the system in complete manner to fulfil the purpose. The module cleaning system shall be complete in all respect and the details shall conform to the relevant IS codes.
- 3.3 Bidder shall install flow meter at pump discharge/ main header for measurement of water consumption.
- 3.4 Total water storage capacity shall be 4000 liters per MW (DC capacity). The storage tank shall be place above ground on RCC Foundation and Tank material shall be FRP. The detail specification of FRP material shall be decided during detail engineering.
- 3.5 Module cleaning system shall design considering the modules shall be washed once in 15 days depending on prevailing site conditions which can be defined during detail engineering.
- 3.6 MCS shall have Either Web page monitoring & control or SCADA monitoring & control and dedicated PLC/controller to provide at least the following data on Modbus protocol.
  - a) Pump on-off status.
  - b) Pump on-off control (Remote)
  - c) Water level status.
  - d) Water consumption.
  - e) Discharge Pressure
- 3.7 Bidder shall provide the Modbus communication details and mapping list for integration of MCS with SCADA system



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.8 Module cleaning system piping network shall be close looped pipe network configuration consists of Main pipe, submain, and branches with isolating valves on both sides.
- 3.9 Entire MCS design, drawings and piping and the instrumentation diagram (P&ID) of Module cleaning arrangement including the sequence of branches, reducers, valves, pressure gauge, tapping points with location of pump(s) and water storage tanks shall be submitted by bidder for approval of Owner during detailed engineering.
- 3.10 Tapping Points shall be made of GI pipe with manual isolating valves & Quick release couplings and shall be provided at regular intervals for fixing the 50 Meter detachable Hose pipes to cover and spray water on entire PV Array area.
- 3.11 The Entire HDPE Piping network shall be laid at least 300mm below the NGL/FGL
- 3.12 The HDPE pipe shall be suitably protected against any impact load. The Piping network at Road crossings and wherever higher loads are expected shall be laid 600mm below the NGL/FGL and covered with higher diameter GI pipe / NP3 Hume pipe at for protection against any heavy loads etc. The bidder may also propose some other protection system for HDPE pipes.
- 3.13 If underground laying is not possible at any location due to hard rock or any site-specific problems, then above ground laying shall be done on concrete Pedestals or anchors subjected to approval during detail engineering.
- 3.14 All HDPE Joints & fittings shall be Electro fusion type.
- 3.15 All fasteners shall be of SS 304 or better grade to fulfill the site requirement for at least 25 years, in case of J-bolts prior approval shall be obtained.
- 3.16 The entire water washing system shall be tested for minimum 0.5 N/mm<sup>2</sup> or double the maximum working pressure, whichever is greater.
- 3.17 Minimum pressure at the outlet of Nozzle shall be 5 Bar
- 3.18 Necessary arrangements shall be made by the bidder to avoid entry of foreign materials like, earth, sand leaf, gravels, etc. into the pipeline network.
- 3.19 Piping network of Module cleaning system shall be interconnected using isolating valves, so as module cleaning shall be continued in case of outage of any sub-system.
- 3.20 Air Release Valves (ARV) shall be placed at every alternate line at highest elevation point in the line to ensure that there is no surging or hammering in the pipelines.
- 3.21 Prefab Chambers and bases shall be used to protect all valve assemblies.





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

3.22 Canopy shall be used to protect pumps & tanks. Bidder to refer the Corrosion category as specified in technical specification and grade of concrete accordingly.

3.23 Suitable Earthing shall be provided as per I.E Rule/Act.

**4.0. AUTOMATED/ROBOTIC CLEANING SYSTEM**

Considering minimal usage of water for module cleaning, Any of the following automated cleaning solutions shall be adopted by the bidder:

Semi-automated Robots

or

Fully automated Robots

**4.1 SEMI-AUTOMATED ROBOTS**

Semi-automated devices come with the flexibility for using a single robot in different modules which are at some distance from each other. Robot shifting from one table row to another requires two workers only. Generally, these robots come with a separate charging box, hence once used can be kept out of panels for charging, this enables a longer life of robot as it faces minimum environmental impact. Module cleaning happens automatically.

**4.2 FULLY AUTOMATED ROBOTS**

This type of Robot uses microfiber / soft nylon bristled material brushes to sweep the dust off, of panels. These are designed for large row of panels situated in dry and sandy environment. Robot makes use of an on-board solar panel and battery to store energy, that allows the robot for cleaning in evening. Hence since start of robot operation, charging and return to its docking station, no manual intervention is required.

**5.0. DESIGN CRITERIA AND TECHNICAL SPECIFICATION:**

The proposed Robot shall have the following characteristics

- |  |   |   |
|--|---|---|
| a) Type of Cleaning                          | : | Water less Cleaning.                          |
| b) Portability                               | : | Table to Table through bridges.               |
| c) Row Heights supported                     | : | As per design                                 |
| d) Power                                     | : | Re-Chargeable Battery / Solar Powered.        |
| e) Control                                   | : | Remote / Local programmable                   |
| f) Warranty                                  | : | 5 Year (Minimum).                             |
| g) Compatible                                | : | Compatible with the project specific modules. |
| h) Operational temperature                   | : | -20°C to 50°C (not less than temp at site)    |
| i) Dimensions (HxWxB)                        | : | Shall be suitable with adopted MMS design     |
| j) Weight                                    | : | Shall be within the module withstand loads    |
| k) Min. Cleaning wattage/day                 | : | 1 MW/Day/robot                                |
| l) No. of persons required to Lift the robot | : | 2 Persons only in case of semi-automatic      |
| m) Docking & Reversing Stations              | : | Bidder to Specify                             |



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**The Bidder shall also ensure following considerations during design:**

- 5.1 The necessary design considerations for mounting the robotic system shall be incorporated in the Module Mounting Structure design, foundation design as well as PV array layout, in addition to the specifications provided elsewhere in this Section.
- 5.2 The system shall be designed for operation under the climatic conditions at site.
- 5.3 Type of Robot shall be finalized at the beginning of the Project only as each system requires some special arrangements for its movement/ fixing.
- 5.4 For robotic cleaning system, long module rows are beneficial to reduce the costs. Hence same needs to be taken care while designing PV array Layout.
- 5.5 MMS Structure design shall be done by considering the Robotic cleaning system requirement and Loads.
- 5.6 Weight of the cleaning device on top of the PV module must be within the allowable loads given by the PV module manufacturer.
- 5.7 Brushes used in robots shall be made of soft nylon bristled material (nonabrasive) and shall not damage the ARC coatings applied on Modules. All the metallic material used shall be corrosion resistant.
- 5.8 Length and width of a Table and climbing slope shall be in line with the selected Robotic cleaning system configuration.
- 5.9 Any land undulations and slope adopted for PV plant design shall be in line with the Robotic cleaning system
- 5.10 Maximum operating Temperature of Selected Robotic system shall be suitable to the Site requirement.
- 5.11 Battery capacity of Robotic system shall be sufficient for at least 3 cleaning cycles without need of any recharge.
- 5.12 Rails shall be installed in between rows if required.
- 5.13 The module manufacturer should provide explicit approval for each cleaning system to be deployed, including confirmation that warranty coverage of the module will not be voided by use of the system.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 5.14 Abrasion of the PV module's anti-reflective coating and scratching of the glass surface should not arise. To evaluate the abrasion risk, cleaning system suppliers should use an independent third party to test the devices.
- 5.15 A non-conductive nylon or similar material brush, sponge, or other mild agitating method may be used with caution. Ensure brushes or agitating tools are not abrasive to glass, EPDM, silicone, aluminium, or steel.
- 5.16 No cell or PV module breakage or damage should occur which could impair the safety, mechanical or electrical integrity of the PV module.
- 5.17 The selected system should be technically robust for the respective operating environment.
- 5.18 No sensitive parts should be exposed to external conditions.
- 5.19 Minimal maintenance of the cleaning device should be required. Ideally skilled/semi-skilled, low-cost labour can be used to perform maintenance on the cleaning devices. Maintenance should be easy, fast and require few tools.
- 5.20 In the case of semi-automatic and fully automated devices the number of hours required for battery charging and the battery lifetime should be considered. Remote battery status monitoring is preferred.
- 5.21 The cleaning system supplier should provide operator training on the correct use of the system.
- 5.22 Given that the economic and operational lifetime of many PV systems is expected to be at least 25 years, the cleaning system supplier also needs to guarantee the supply of spare parts for the same period.
- 5.23 The Module mounting structure/ table shall be designed and modelled considering connection details for dry/robotic cleaning for travelling from one table to another.
- 5.24 Mode of working shall be automatic cleaning, IP65 protection level, self-powered system with battery backup (without external supply), it should be compatible & integrated with SCADA.
- 5.25 Bidder shall ensure that all docking and reversing stations of the robot are accessible.
- 5.26 Bidder shall demonstrate successful operation of robot on the MMS tracker to the satisfaction of Owner
- 5.27 Bidder shall supply the complete dry/water less cleaning system at site as per approved array/plant layout drawings, and supervision of installation & commissioning by supplier along



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

with Owner, all other activities related to robotic cleaning including storage, loading, unloading, transportation within site, its supply including start end docking station, bridge material required complete in all aspect, nuts and bolts, fasteners, installation, coordination, commissioning and any other activity not specified herein but required for successful commissioning of robotic cleaning system is included in the scope of Bidder.

**6.0. DATA TO BE FURNISHED BY BIDDER AFTER AWARD OF CONTRACT:**

**6.1 Drawings / Documents for Approval and or Information:**

- i. Layouts with all necessary details
- ii. GA, Data Sheets & Cross-sectional drawings
- iii. Guaranteed Technical Particulars
- iv. Type of Arrangement required in MMS design
- v. Design Documents with All required calculations
- vi. Detailed quality assurance plans.
- vii. Any other drawings/documents considered necessary.
- viii. Quality certifications from NABL accredited or Reputed Test lab
- ix. Schedule for component replacement
- x. Type test certificates valid for five years for all equipment/accessories being supplied under this contract.
- xi. Routine test certificates for all equipment/accessories being supplied under this contract.
- xii. Instruction manual containing detailed instructions for all erection, testing and operation requirements.
- xiii. Warranty Certificates
- xiv. Detailed instructions for the installation and operation.
- xv. Approval from module and tracker manufacturer on the robot used.
- xvi. All detailed catalogues and literature of the Robots/ Equipment supplied.

Any Design, Drawings, Test reports and any other documents which are required and related to the system shall be submitted for Owner Approval or Information as and when requested.

**7.0. GUARANTEED TECHNICAL PARAMETERS (GTP)**

The bidder shall furnish the guaranteed minimum technical particulars as stated below in Clauses 7.1 and 7.2.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**7.1. WATER BASED MCS**

Item	Description	UoM	To be filled by Bidder
General	Total no of modules in plant	Nos	
	Frequency of cleaning each module	Days	
	No of module to be cleaned per day	Nos	
	Considered cleaning time	Hrs	
	No of nozzles to be operated simultaneously	Nos	
	Water pressure at Nozzle outlet	Bar	
	No of module to be cleaned per hr	Nos	
Water	Water required to clean each module	Lit	
	Water required per day cleaning	Lit	
	Water required per cleaning cycle	Lit	
	Assumed water loss in network	%	
	Water loss in network	Lit	
	Water flow rate required for module cleaning	Lit/hr	
Pipe	Main Pipe Size considered	Mm	
	Main Pipe rating	PE & PN	
	Branch Pipe size Considered	Mm	
	Branch Pipe rating	PE & PN	
Pump	Pump flow rate	L/M	
Tank	Water tank capacity with 2 days storage	KL	

**7.2. ROBOTIC CLEANING SYSTEM**

Item	Description	UOM	To be filled by Bidder
Dimensions	Length	mm	
	Width	mm	
	Height	mm	
	Weight	Kg	
Operation	Cleaning Mode	type	
	Speed	m/min	
	Maximum climbing angle	°(Degree)	
	Maximum gap without bridge	(Mm) <sup>2</sup>	
	Cleaning distance on Full charge	(km) <sup>3</sup>	
	Operating Temperature	° C	
Battery	Material	type	
	Voltage	VDC	
	Capacity	AH	



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

	Life cycles	No	
<b>PV panel</b>	Power	Wp	
<b>Drive Motor</b>	Quantity	No	
	Power	W	
<b>Brush Motor</b>	Quantity	No	
	Power	W	
<b>Brush</b>	Material	type	
	Quantity	No	
<b>Communication Mode</b>	Network	type	
	Range	M	
	Power	mw	
<b>Drive wheel</b>	Quantity	No	
	Material	type	
<b>Limit wheel</b>	Quantity	No	
	Material	type	
<b>Shell</b>	Material	type	
<b>Warranty</b>	Time	years	



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A8 – ESE LIGHTNING PROTECTION FOR PV YARD**

**1.0 Lightning Protection for PV Yard**

ESE type lightning protection shall be provided to protect all building / tall structures and PV array from direct lightning strikes. The purpose is to reduce the over voltage due to atmospheric disturbances such as lightning, etc. to a safe level before it reaches the PV or other sub-system components. The design and engineering shall make use of most recent international standards and best design practices.

**2.0 Codes & Standards**

<b>Codes</b>	<b>Description</b>
NFC 17-102 :2011	Protection against lightning
IEC 60068	Environmental testing for electronic component
EN ISO 6988:1997	Metallic and other non-organic coatings sulfur dioxide test with general condensation of moisture
EN 62561	Lightning protection system component

**3.0 Design Criteria**

- 3.1 The system shall include components viz., air termination equipment, Lightning Flash Counter, mechanical support, down conductor(s) and maintenance free earthing system.
- 3.2 The ESE lightning conductor shall operate permanently with both positive & negative lightning strikes.
- 3.3 Necessary foundation / anchoring for holding the lightning conductor in position to be made after providing due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.
- 3.4 Supply of two nos of minimum 35 sq.mm of PVC ST2 insulated flexible single core copper down conductor along with the fixing accessories along the ESE lightning arrester.
- 3.5 Each lightning arrester should be provided with a Lightning Strike Recorder (LSR) and mounted on a down conductor to effectively count the number of lightning strikes captured by the ESE Terminal.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- 3.6 Minimum Two numbers of dedicated maintenance free earth pits shall be provided for each lightning arrester. Detailed specification of earth pits shall be as mentioned elsewhere in the tender document.
- 3.7 No shadow shall fall on PV Modules due to ESE LA structures. Appropriate care shall be taken while designing PV array layout.
- 3.8 Number and location of ESE air terminal shall be decided during detail engineering. For this purpose, design calculation considering protection level IV (minimum) and AutoCAD drawing of the layout of ESE terminal shall be submitted to GIPCL for approval.

**4.0 Technical Parameters**

Sl. No.	Item Description	Unit	Data
1.	Technology	-	Early Streamer Emission
2.	Reference Standard	-	NFC 17-102
3.	Level of Protection	-	Level - IV
4.	Radius of Protection	M	107 (Maximum)
5.	Height of mast	M	5, above PV Module structure
6.	Down conductor Material	-	Copper
7.	Lightning Strike Recorder Degree of Protection	-	IP 67
8.	Material of mast	-	Galvanized Iron, Hot dip galvanized
9.	Seismic Acceleration		0.36g
10.	Test Link	-	Required
11.	Guy wire	-	As per design requirement

Type test certificates as per relevant standards for the tests conducted within five years of the date of order placement shall be available and to be submitted for review and record.

**5.0 Data to be furnished by vendor after award of contract**

**5.1 Drawings / Documents for Approval:**



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- i. Bidder shall submit the drawings, calculations and detailed specifications of the PV array lightning protection equipment
- ii. Guaranteed Technical Particulars
- iii. Detailed quality assurance plan.
- iv. Any other drawings/documents considered necessary.
- v. Type test certificates as per relevant standards for the tests conducted as per CEA guidelines to be submitted.

**5.2 Drawings / Documents for information:**

- i. Test certificates for all equipment/accessories being supplied under this contract
- ii. Instruction manual containing detailed instructions for all installation, erection, testing and operation requirements.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A9 – WEATHER MONITORING SYSTEM**

**1.0 Weather Monitoring Station**

- 1.1 The Weather Monitoring Station shall be provided with all the equipment to monitor relevant parameters for the assessment of the performance of the PV Power Plant. The number of sensors shall be as per IEC 61724 – 1.
- 1.2 Each Weather Monitoring Station shall be capable of monitoring the following variables:
- a) Global horizontal irradiance from ISO secondary standard class
  - b) Incident irradiance in collector plane from a calibrated reference cell from the module – 2 Nos.
  - c) Wind direction and velocity (additional installations might be required for tracker wind alarm trigger)
  - d) Ambient temperature
  - e) Back of module cell temperature
- 1.3 Bidders are advised to ascertain themselves, the applicable regulation related to weather data which must be transmitted to control centers like SLDC/RLDC (Telemetry). Any signal/parameter/equipment though not specifically mentioned but which are required as per statutory regulation are also included in the scope of bidder.
- 1.4 Bidder scope cover supply of complete system and its installation that includes Data logger, Automatic Module Cleaning System, cabling, software setup and interface with solar SCADA as per the technical requirement mentioned herein. Bidder shall also provide Solar PV module and its support structure.
- 1.5 WMS shall consist of a weather-proof enclosure containing the data logger, rechargeable battery and the meteorological sensors with an attached solar panel mounted upon a mast / Supply from the UPS. WMS should get an Uninterrupted Power Supply. The system shall report in real time via hardwired interface and soft links to SCADA. It shall also save the data for later recovery.
- 1.6 WMS shall continuously measure solar radiation, ambient temperature, wind speed and all other weather parameters.
- 1.7 The system shall be provided for making site-specific solar resource measurements / to support operational needs for system performance. The system shall provide sub-hourly measurement of the Global horizontal and inclined radiation, Relative humidity, Wind speed,



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Wind direction, Atmospheric pressure. Additional instruments shall be provided as required for site-specific requirements.

**1.8 The configuration of a WMS shall consist of the following in minimum:**

- a) A weather-proof enclosure (SS316) containing the data logger, rechargeable battery, and remote interface
- b) Metrological sensors
- c) Power supply
- d) Mast (SS 316 L or aluminum, screws, nuts in SS or aluminum)
- e) The height of the Mast shall take into consideration the site conditions, obstructions, required measurements etc.

- 1.9 For Solar Project above 40 MW bidder shall install minimum Two soiling station in the solar PV field for each capacity plant size. Cleaning frequency of soiling station shall be like the module cleaning frequency to calculate Soiling loss precisely. The Soiling Measurement System shall measure the performance loss from a PV array due to accumulation of dust, dirt, and other site-specific contaminants, collectively known as soiling. Soiling stations shall use two full -sized modules. One is allowed to soil naturally, while the other is cleaned with an automatic washing system. Power and energy are monitored for both modules.

Each instrument shall be supplied with necessary cables, transmitters, and accessories (Trackers, Mounting and base stand etc.) provided by OEM of the sensors only.

**Following requirements are to be taken care by bidder: -**

- a) Data logger shall be field tested and shall be in satisfactory operation for a period not less than 6 Months.
- b) Data logger shall be calibrated (Measurement uncertainty less than 2%) before dispatch and calibration shall be traceable to any National/International lab. Data logger shall have flash memory not less than 1GB for local storage of data.
- c) Bidder shall submit the write up detailing the philosophy of measurement of soiling loss in his proposal. Measurement shall be based on comparison of Isc & Power.
- d) Datalogger shall have feature that includes but not limited to Moving Average calibration, Time Integration etc.
- e) Bidder to facilitate the interfacing of data of Soiling Station to Solar SCADA on Modbus TCP/IP for trending, storage, retrieval, and display of data
- f) Automatic Cleaning System
- g) The automatic cell-washing system cleans the PV reference module for accurate measurements.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- h) The system uses a suitable liquid spray to clean the reference module at user-determined intervals.
- i) The liquid tank is minimum 100 Liter. Under typical soiling conditions the liquid reservoir must be refilled periodically using the suitable liquid specified by OEM of Soiling station/PV module supplier.
- j) Bidder shall supply 2 Nos of spare spray nozzle along with supply.

## 2.0 CODES AND STANDARDS

2.1 All equipment, systems, software, and services covered under this specification shall comply with all currently applicable statutes, regulations, and safety codes in the locality where the equipment shall be installed. All codes and standards referred shall be understood to be the latest version on the date of offer made by Bidder unless otherwise specified. If such standards do not exist for any equipment or system, that equipment shall comply with the applicable recommendations of the following professional institutes

<b>Codes</b>	<b>Description</b>
IEC 61724	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis.
ISO 9060: 1990	Solar Energy – Specification and Classification of instruments for measuring hemispherical solar and direct solar radiation
ISO/TR 9901: 1990	Solar Energy – Field Pyranometers – recommended practice for use
NEC	The National Electrical Code
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturers Association
ICEA	Insulated Cable Engineers Association
OSHA	Occupational Safety and Health Act
ANSI	American National Standards Institute
NFPA	National Fire Protection Association



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

CENELEC	European Committee for Electro technical Standardization
UL	Underwriters Laboratory
ASTM	American Society of Testing and Materials
ISA	International Society of Automation
IEC	International Electro technical Commission

- 2.2 Standards not indicated in the specification are acceptable subject to approval by the Owner / Owner's Consultant if they are established to be equal or superior to the standards indicated in the specification. In case of conflicts between the standards and this specification, this specification shall govern.

### 3.0 DESIGN CRITERIA

- 3.1 Weather stations shall be placed in representative locations within the plant including measuring instruments and all necessary software & hardware required to integrate with SCADA to enable availability of data in SCADA.

Each secondary weather station shall comprise (Applicable when Solar Project capacity is 100 MW or more, for every 100 MW one secondary weather station shall be required) (100MW plant size means plant is located in single location with single control room and dedicated switchyard):

- a) GHI and POA Pyrometer: Calibrated pyrometer to record the solar radiation available on the plane of array of the Modules with a target measurement uncertainty of  $\pm 3\%$ .
  - b) Resistance thermometers (e.g., Pt100, Pt1000) or equivalent to measure ambient temperature and the temperature of Modules (on the back of the cells).
- 3.2 The weather stations shall be specified, calibrated, and supervised by an independent body.
- 3.3 The provider shall ensure that the weather station comply (equipment and installation) with the environmental constraints of the location of the PV plant (based on its GPS coordinates) on which a weather station is to be installed. It is the responsibility of the provider to verify the environmental constraints and meet or exceed the associated requirements.
- 3.4 A reference pyranometer is used during commissioning tests and regularly during the PV plant lifecycle to ensure a proper orientation and functioning of the pyranometer of the



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

weather station. To ensure that the reference pyranometer has the same orientation than the ones equipped with the weather station, two mounting brackets (one for the tilted pyranometer and one horizontal pyranometer) shall be provided.

- 3.5 The sensor's mast shall be made available with 2 mounting options:
- a) Option 1: Fixing brackets for installation of the mast on a concrete wall for the sensor, autonomous fixing brackets for the PV panel support.
  - b) Option 2: Autonomous mast (such as tripod) for sensors, PV panel, cabinet, etc.

The mast shall ensure that the Pyranometers are placed at a height from the ground sufficient to avoid any shading from surrounding elements (trees, hill, buildings, PV panels, etc.).

- 3.6 The mast, cabinet and all metallic parts shall be grounded directly at an earth point at the bottom of the mast and connected to a ground rod of 3m minimum vertical inserted into the soil.
- 3.7 All grounding cables shall end inside the cabinet to a terminal from which it is possible for the final installer to install the grounding from the cabinet to the ground.
- 3.8 For each of the installed Weather Monitoring Stations, following minimum measurements shall be made available in SCADA:
- a) Ambient temperature, in °C
  - b) Back of module cell temperature, in °C
  - c) Global Horizontal Irradiance from pyranometer, in W/m<sup>2</sup>
  - d) Global irradiance in collector plane from a pyranometer, in W/m<sup>2</sup>
  - e) Wind speed, in m/s
  - f) Wind direction, in degrees
  - g) Any other weather parameter required by SLDC/GETCO
  - h) Weather station communication status
  - i) Direct Soiling loss readout shall be available in SCADA for display and recording.

- 3.9 The weather stations (Pyranometer, anemometer and temperature sensor) shall be connected to switch panel located in the control box using Ethernet cable (UTP Cable CAT 6. Distance < 100m) whose main characteristics shall be defined at the monitoring design.

- 3.10 A compact station with all the measurements integrated (except pyranometer & module temperature sensor) can be provided. Each instrument shall provide separate 4-20 mA output



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

(soft link RS-485) to SCADA system. Battery voltage monitor signal (4-20mA) shall be provided to SCADA.

- 3.11 All the measurements at weather station to be integrated with data logger with one number output connection RS-485 type interface to SCADA.
- 3.12 The specific configuration of the system, suitable for the subject site, with all sensors as required shall be included.
- 3.13 The system shall report in real time and save the data for later recovery.
- 3.14 Each instrument shall be supplied with necessary cables provided by OEM of the sensors only. Pyranometer Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. All equipment supplied shall be provided with valid calibration certificate. Bidder shall provide Instrument manual in hard and soft form
- 3.15 Provider shall be responsible for the following activities:
- a) Assessment that the installation location complies with state-of-the-art requirements for a weather station installation
  - b) No shadows (from trees, buildings, hills, etc.) from sunrise to sunset affecting the pyranometers
  - c) Absence of cooling or heating systems nearby that may affect ambient temperature readings
  - d) Absence of ventilation or wind protection (walls, buildings, etc.) that may affect wind vane and anemometer readings
  - e) Assessment of any damages during transportation and providing necessary help to the Owner for any follow-up action
  - f) Mechanical verification after installation and before energizing
  - g) Co-ordinate with Owner / Engineer during complete loop checking of the plant
  - h) Consolidate all loop checking reports with Owner / engineer
  - i) Redlining and as building of all documents and drawings
  - j) Provide commissioning assistance for tuning of loops, implement minor changes in interlocks, graphics etc.
- 4.0** Bidder shall submit weather station BOM for GIPCL approval during detailed engineering.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**5.0 TECHNICAL PARAMETERS**

Sl. No.	Description	Technical Requirement
1.	<p>Pyranometer shall include the following in minimum characteristic:</p> <ol style="list-style-type: none"> <li>1. Principle: Thermopile</li> <li>2. Response Time (95% of final value): &lt; 5 sec</li> <li>3. Standard:</li> <li>4. Spectral Response</li> <li>5. Irradiance range</li> <li>6. Spectral range</li> <li>7. Sensitivity</li> <li>8. Time response (95%)</li> <li>9. Non-linearity</li> <li>10. Temperature Response</li> <li>11. Temperature dependence of sensitivity</li> <li>12. Temperature Response</li> <li>13. Tilt error</li> <li>14. Zero offset thermal radiation</li> <li>15. Zero offset temperature change</li> <li>16. Operating temperature range</li> <li>17. Uncertainty (95% confidence Level)</li> <li>18. Non-stability</li> <li>19. Resolution</li> <li>20. Input Power for Instrument&amp; Peripherals</li> <li>21. Ingress Protection (IP) rating</li> </ol>	<p>Spectral Pyranometer</p> <ol style="list-style-type: none"> <li>1. Thermopile</li> <li>2. &lt;5 sec</li> <li>3. Secondary Standard Pyranometer as per ISO 9060</li> <li>4. 0.31 to 2.8 micron.</li> <li>5. 0-1200 w/ m<sup>2</sup></li> <li>6. 200 to 3600 nm</li> <li>7. 7 <math>\mu</math>V /w/m<sup>2</sup> or better</li> <li>8. Max 15 s</li> <li>9. 0.5%</li> <li>10. <math>\pm</math>2%</li> <li>11. Less than 0.5%</li> <li>12. Max <math>\pm</math>2%</li> <li>13. <math>&lt;\pm</math>0.5%.</li> <li>14. <math>\pm</math>7 w/m<sup>2</sup></li> <li>15. <math>\pm</math>2 w/m<sup>2</sup></li> <li>16. - 0 deg to +80 deg C.</li> <li>17. Max 2% (Hourly)</li> <li>18. Max 2% (Daily)</li> <li>19. Max <math>\pm</math>0.8%</li> <li>20. Min <math>\pm</math>1 W/m<sup>2</sup></li> <li>21. 230V ac. (If required)</li> </ol>





**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Technical Requirement
2.	Wind Speed (Anemometer)	<p>Sensor shall be provided as approved by Owner. Speed range with Accuracy limit <math>\pm 0</math> to 60 m/s (0 to 112 mph)</p> <p><b>Principle:</b> Frequency proportional to wind speed/Ultrasonic Sensor</p> <p><b>Threshold:</b> 0.3 m/s</p> <p><b>Operating Temperature:</b> 0 to 50 deg C</p> <p><b>Accuracy:</b> 3% (up to 35 m/s), 5% (Above 35 m/s) RMS</p>
3.	Wind direction (Wind vane) Rotating cup type	<p>Sensor shall be provided as approved by Owner. Accuracy limit 0 to 360 deg Accuracy <math>\pm 4</math> deg Operating Temperature: 0 to 50 deg C</p>
4.	Pressure transducer (Barometric Pressure):	<p>Accuracy shall be within <math>\pm 0.3</math> to 1 mb. Linearity shall be <math>\pm 0.25</math>mb or better. Repeatability shall be <math>\pm 0.03</math> mb or better. Stability shall be <math>\pm 0.1</math> mb per year or better. Response time shall be 500ms or better. Output signal 4 - 20mA.</p>
5.	Ambient Temperature Sensor	<p>Duplex type, PT – 100/1000, with accuracy of <math>\pm 0.25</math> deg C, response time 1-2 seconds, Range: 0-100 deg C, operating temperature: 0 to 100 deg C; Spring loaded mineral insulated three (3) wires RTD. IP 65 or equivalent degree of protection for enclosure. Material of accessories (name plate, etc.) shall be SS. Element lead size shall be 18 AWG. The insulation resistance at 540 Deg C shall not be less than 5M ohms. Repeatability over Full range shall be better than 0.02%.</p>
6.	Humidity Cell (Relative Humidity):	<p>The principle of the operation of the instrument shall be based on thin film with capacitive sensor. The range shall be 0-100% RH. Accuracy shall be</p>



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Technical Requirement
		± 3 % of full-scale reading. Resolution 1%, operating temperature 0 to 50 deg C.
7.	Rainfall	a) Meas. Range: 2cm <sup>3</sup> – volume of bucket 0~10 mm/min b) Accuracy: ± 2% c) Operating temp: -35 ~ 70°C d) Output signal: 4~20 mA e) Collecting surface: 200cm <sup>2</sup> /WMO Standard
8.	Seismic Acceleration	0.36g
9.	Data Logger	a) Resolution of AI card better than 1 micro amp (16 bits with 1.6 second filter time) b) Linearity of AI card better than 10 micro amps c) Channel speed (min 16channel/sec) d) Serial input (RS-485) connection to be present e) Analog input channel should be protected against short circuit and over current protection f) Input range for current to be (-)28 to +28 mA g) Accuracy to be better than +/-0.1% reading h) The module to be fitted with disconnects to allow isolation of an individual input to allow work on the loop to continue safely i) Update speed of analog input module to be min. 110ms j) Each module shall have channel failure indication ✓ Indication for failure of internal self-diagnostic routine.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Sl. No.	Description	Technical Requirement
10.	Soiling Index measurement	a) Soiling Loss Index: Can detect ~1% b) Solar Modules: Up to 300 W crystalline or thin film c) Maximum Voltage: 50V d) Maximum Current: 20A e) Measurement Accuracy: ~ 2 Mv f) Power Supply: 26 Ah Battery 12V, 26AH SMF Battery with Battery Box
11.		The system shall consist of an automatic cleaning system that prevents soiling accumulation on the PV reference module (clean one), another PV module (Soiled one) which is allowed to accumulate soiling at the site-specific rate, an electronic data acquisition and analysis unit. All components are provided in outdoor rated NEMA 4/IP 65 enclosures for long-term outdoor use. All cables are rated for outdoor use.

### 6.0 Drawings / Documents for Approval

- a) Fabrication and general arrangement drawing for cabinet/panel.
- b) Inter panel wiring, detailed drawings for panels interconnecting drawings.
- c) Support & mast mechanical design calculation.
- d) Datasheet of all the items, cables supplied including bought out materials
- e) Spares list
- f) Concrete foundation or anchorage design calculation.
- g) All test certificates including calibration reports, degree of protection certificates and Explosion proof certificates for all services.
- h) As Built Documents
- i) O&M manual after design freeze



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**A.10 - SOLAR PHOTOVOLTAIC (SPV) MODULES**

**1.0. SCOPE OF WORK**

The detailed scope of work in accordance with this specification is elaborated below. The scope of the bidder shall be deemed to include all such items, which although are not specifically mentioned in the bidding documents and/ or in bidder's proposal but are needed to make the system complete in all respects for its safe, reliable, efficient and trouble-free operation and the same shall be furnished unless otherwise specifically excluded as per section terminal points and exclusions.

**1.1. SCOPE OF SUPPLY**

- a) The scope of supply includes manufacturing, testing, packing and forwarding, transportation, unloading, handling, installation of solar PV modules.
- b) The bidder shall supply 0.5% of the awarded PV module capacity as mandatory spares in addition to the awarded PV module capacity.
- c) This specification lays down the requirements and tests of solar PV module for ground mount applications.
- d) PV modules shall be suitable for the site conditions, must have proven successful operation in utility scale photovoltaic project.
- e) PV module shall perform satisfactorily with operational temperatures between minimum -40°C and maximum +85°C and shall be available to work under 0-85% relative humidity.
- f) The PV module shall be made of high-quality solar cells, laminated in ultraviolet stabilized polymer material like EVA, polyester and thermally toughened low iron, tempered / heat strengthened glass and back sheet (Transparent) / glass material shall be high quality according to relevant international standards and IEC 61730.
- g) All materials used should have a proven history of reliability and stable operation in external applications. Each PV module shall be checked for conformity with the relevant standard and shall have positive power output tolerance only. No negative tolerance shall be accepted.
- h) PV module shall be provided with anti-corrosive/ weatherproof screw-fitted, having aluminum anodized finish frame (for framed module with coating thickness considering site corrosive nature) with DC cable and connector. In case the module is frameless, suitable retaining clips/ clamps used for installing the modules shall not damage the glass surface in contact with the



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

retaining clamp.

- i) PV modules shall be equipped with minimum three bypass diodes to minimize power drop caused by shade. The module shall be designed for 1500 V dc system.
- j) Modules shall be made of light weight cells, resistant to abrasion, hail impact, rain, water and environmental pollution. The PV modules shall be provided with anti-reflection coating and back surface field structure to increase conversion efficiency.
- k) Efficiency of PV modules at standard test conditions (STC: Irradiation 1000 W/m<sup>2</sup>, cell temperature 25°C and AM = 1.5) shall not be less than 20% and fill factor of the module shall not be less than 0.70.
- l) Module pig tail cables shall be UV resistant solar DC copper cable of lengths of 300 to 500 mm with maximum tolerance of +50 mm as per the project design requirement and of size 4 mm<sup>2</sup> with DC connectors adaptive to MC4 type connector directly. The junction box shall be split type with suitable cable connection between two PV Modules in a daisy chain arrangement. MC4 type connector should be TUV/ any accredited certified. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector. However, any different design and length of the pig tail cable offered (without any extra cost) shall be reviewed during detail engineering.
- m) Total DC Capacity of PV Module to be supplied for the SOLAR project should be minimum (40 %) higher than the AC rating in MW.
- n) Peak power rating of the individual module shall not be less than 540 Wp.
- o) SPV module shall have module safety class-II and should be highly reliable and must have minimum operating life of 25 years.
- p) SPV Module shall withstand adverse climatic conditions, such as high speed wind, blow with dust, sand particles, saline climatic / soil conditions and for wind 180 km/hr on the surface of the panel.

**1.2. REQUIREMENTS FROM BIDDER**

Module manufacturers shall provide the methodology for handling, unloading, storage, installation, testing and commissioning of the PV module. Owner / GIPCL shall ensure that module shall be installed as per the furnished methodology. If required, module manufacturer would have to associate with the Owner's / GIPCL's installation and commissioning (I&C) agency.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

Module OEM shall be responsible for loading the modules on suitable carriage. The details of transporters/ type of carriage for safe transportation of modules without breakage shall be explicitly communicated to Owner/ GIPCL and or BoS vendor of the concerned project.

Module manufacturer must provide a suitable checklist for safe unloading of modules and procedure for safe and proper storage of modules at site.

### 1.3. INSURANCE

The bidder's insurance liabilities pertaining to the scope of works are detailed out in elsewhere in bidding document.

### 2.0. DEFECTIVE MODULE

#### DEFECTIVE MODULE

Following are few criteria for defective solar PV module:

- a) Physical:
  - i. Frame – sign of corrosion
  - ii. Back sheet – sign of bulging and decolouration
  - iii. Front glass – sign of cracks
  - iv. Cell – sign of decolouration and cracks
  
- b) Electrical:
  - i. Defective module is one with either Isc (short circuit current) or Voc (open circuit voltage) or their combination thereof less than 10% of average of 7-10 healthy modules of identical nominal rating.
  - ii. Hot spot: A hot spot shall be defined as difference in temperature within the PV module of 30° at 1000 W/m<sup>2</sup>. The product warranty shall include an onsite hot spot testing procedure, setting the conditions under which the modules will have to be replaced.

#### Conditions for defective module

- i. The determination of defective modules shall be carried out for initial troubleshooting and preliminary assessment at site. In such a scenario, the defective modules shall be replaced with the healthy ones from mandatory spares by the O&M vendor to reduce the downtime of the solar PV plant.
- ii. The selection of healthy modules shall be done jointly by Engineer In-charge (in consultation with the module manufacturer and as per the approved technical documents, if any) and erection/ O&M Vendor.
- iii. Module shall also be declared as defective, if its output power is derated more than



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

it's deemed Wp capacity taking consideration of yearly degradation. However, the responsibility for measuring the PV module performance output using reputed make PV analyzer etc., shall lie with erection/ O&M vendor.

- iv. Once these PV modules are categorized as defective PV modules at site, the responsibility and cost of further action to either transport to third-party laboratory for final assessment or replace the PV modules shall lie with the module manufacturer. The determined course of action shall be jointly finalized by module manufacturer and Owner/ GIPCL within reasonable time for settlement of the defective PV modules issue.
- c) Bidder will replace/ rectify the defective PV modules within a reasonable time. In case of non-availability of same rating/ wattage as of the defective PV modules, bidder can supply higher power rating/ wattage modules of the same physical dimensions for replacement.
- d) The period of replacement of defective modules shall be decided by engineer-in-charge based on the number of failed modules and availability of mandatory spares at site.

### 3.0. PROVENESS CRITERIA FOR SOLAR PV MODULES

In case the bidder is unable to meet the tender requirement by themselves, the bidder can sub-contract part or full procurement of PV modules for this package complying to the following conditions:

The sub-vendor or its holding company/ subsidiary company should be a PV module manufacturer with 540 Wp, or above rated PV module listed in the latest "ALMM" order issued by MNRE as on the last date of bid submission.

### 4.0. TECHNICAL PARTICULARS OF SOLAR PV MODULE

#### 4.1. DATA SHEET

Bidder shall submit the data sheet for offered PV module in line with following table.

**Table 1: Technical Details of Solar PV Modules**

Sl. No.	Parameter	Unit	Technical Requirements	Bidder Reply
				*(with actual details)
<b>A. General</b>				
1.	Application	-	Utility scale ground mounted project	



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

2.	PV module manufacturer name	-	*	
3.	Country of origin of the PV module cell	-	*	
4.	Model no. of the PV module	-	*	
<b>B. Technical Details</b>				
1.	Cell type	-	Crystalline silicon – Bifacial (full/ half cut cell/ mono PERC/ n-type/ p- type)	
2.	Cells per module	No.	*	
3.	Type of design	-	With frame/ frameless	
	a) Frame material applicable only for modules with frame)	-	Corrosion resistant materials, coating of minimum 15 µm thickness and frame thickness of at least 30 mm	
	b) Front glass and back sheet / back glass	-	*	
	i. Front glass type	-	High transmission, low iron, tempered glass with anti-reflective coating	
	ii Back sheet / glass	-	*	
4.	Mounting arrangement - screw / clamp	-	Shall be clearly stated in the installation manual	
5.	Mounting hole distance (farthest holes along longer edge)	mm	1400	
6.	Module dimension (L x W)	m	Bidder shall mention	
7.	Weight	kg	<33	
8.	Water quality requirement for washing the module in case of wet cleaning	-	Please provide the details	
<b>C.</b>	<b>Electrical data</b>			




**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

1.	<b>Electrical data</b>			
	a) Nominal maximum power (Pmax) @ STC	Wp	Above 540, bidder to mention	
	b) Operating voltage (Vmp) @ STC	V	*	
	c) Operating current (Imp) @ STC	A	*	
	d) Open circuit voltage (Voc) @ STC	V	*	
	e) Short circuit current (Isc) @ STC	A	*	
2.	Module efficiency at STC	%	20 (minimum)	
3.	Fill factor	%	70 (minimum)	
4.	Operating temperature	°C	-40 to +85	
5.	Maximum system voltage	V dc	1500	
6.	Power tolerance	Wp	0 to (+) 4.99	
7.	PID free solar cells	-	Yes (should comply with IEC 62804)	
8.	Current binning	-	Required 3 stage. Please mention the binning pattern. Module wattage bin offered shall not be less than 5 Wp.	
9.	Bifaciality factor	%	70 (minimum), if applicable	
10.	Packing (as per current binned)	-	Required	
11.	Module terminal box split type			
	a) IP	-	68	
	b) Terminal cable	-	UV protected cable(copper)	
	c) Cable length	mm	*	
	d) Terminal connector	-	Solar PV connector (MC4)	
12.	Temperature characteristics			
	a) Temperature coefficient of power (Pmax)	% / °C	*	


**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

	b) Temperature coefficient of voltage (Voc)	% / °C	*	
	c) Temperature coefficient of current (Isc)	% / °C	*	
	d) Nominal operating cell temperature	°C	*	
13.	Bypass diode			
	a) Efficiency	%	> 99	
	b) Voltage drop	V	Not more than 0.7	
	c) Operating temperature	°C	(0 - 85)	
14.	Front Glass material			
	a) Glass thickness	mm	Bidder to specify	
	b) Anti-reflective coating	-	Required	
	c) Transmittance value	%	90 (minimum)	
15.	Encapsulant	-	Should be UV resistant	
16.	Sealant to seal PV module edges and fix frames	-	Sealant should be made of silicone material	
* To be indicated by the bidder.				

**4.2. STANDARD TESTING CONDITION AND QUALITY REQUIREMENTS**

The applicable codes and standards are as mentioned below.

**Table 2: Codes and Standards**

Sl. No.	Codes and Standards Requirements	Bidder's Confirmation
1.	The PV module must qualify to either IEC 61215 (Ed. 2) or IS 14286: 2010 – Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval (First Revision)	
2.	PV modules must qualify to IEC 61730 (Part 1 and 2) or IS/IEC 61730 , for safety qualification and testing.	



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

3.	Corrosive atmosphere resistance testing to salt mist (IEC 61701 Ed. 2)	
4.	The PV modules manufacturer must have valid test certificates for their qualification as per IEC/ BIS standards by one of the NABL accredited test centers in India, in case such test facility may not exist in India, test certificate from reputed ILAC member body accredited labs abroad will be acceptable, and the type test reports shall be submitted for approval.	

#### 4.3. QUALITY ASSURANCE PLAN

The minimum quality assurance/ quality control (QA/ QC) requirements and services bidder is expected to provide to assure “Quality Assurance” are described in this section. “Quality Assurance” is defined as the entire programme adopted by the Bidder during engineering, procurement and construction to assure conformity with the contract specifications. QA/ QC procedures proposed by the Bidder should address the QA/ QC requirements under the following phases of the project:

- a) Engineering - Prior to finalization of the contract, the bidder shall prepare and submit a product QA and QC that covers the engineering phases of work. The plan will be designed for this project and will address the specifics of how the bidder will control, monitor and verify the requirements contained in this section.
- b) Procurement - It is the Owner’s intent that the bidder deals only with sub-manufacturers (vendors) of components who have established and demonstrated effective quality assurance and quality control programs. Owner does require, however, that the bidder perform such normal inspection of sub-manufacturers’/ vendors’ work as is necessary to obtain equipment and materials conforming to the project specifications and their supporting documents (applicable codes and industry consensus standards) and good engineering, fabrication practices. Source quality control is also a valuable input for confirmation of delivery performance.
- c) Construction including commissioning testing - Owner will have a QA/ QC organization to audit the bidder’s QC effort. The assigned Owner’s personnel will provide assurance to Owner’s management that the work meets specifications, however, the basic inspection and quality control responsibility is vested with bidder.

Bidder shall submit documents to demonstrate that he (the bidder) and his sub-vendors possess QA/ QC programs, meeting the requirements set forth in this section and specified elsewhere in this tender document. Bidder shall prepare quality assurance plan (QAP) for all components to cover the overall quality assurance requirements and shall submit along with the bid.



#### 4.4. MATERIALS INSPECTION PLAN – MANUFACTURING STAGE AND / OR PRE-DISPATCH INSPECTION

Following tests and/ or checks to be performed by manufacturer. These would be taken care during third party inspection (TPI) of module during manufacturing stage and/ or pre-dispatch inspection (PDI). Module QAP and quality checks shall be provided to Owner/ GIPCL prior to signing the final contract agreement.

**Table 3: Pre-dispatch Inspection Test**

Sl. No.	Sample Test	Sampling Reference/ Standard
1.	Visual/appearance	As per special inspection level S-4 and AQL 2.5% as per IS 2500 (Part 1): 2000
2.	RFID tag	As per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1):2000
3.	Flash test and I-V curve measurement	As per special inspection level S-4 and AQL 1.5% as per IS 2500 (Part 1): 2000
4.	Electroluminescence (EL) testing	As per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1):2000
5.	Insulation resistance test	Sampling as per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1): 2000
6.	Robustness of termination test	One sample per lot as per IEC 61215 or IS 14286: 2010
7.	Mechanical load test	One sample per lot as per IEC 61215 or IS 14286: 2010

This is an indicative list of tests/ checks. The manufacturer/ bidder is to furnish a detailed quality plan indicating the practice and procedure along with relevant supporting documents. Visual and EL acceptance criterion to be submitted along with MQP.

1. GIPCL has right to inspect during manufacturing of the ordered quantity starting from incoming raw material till packaging and dispatch.
2. Random sample shall be selected by authorized agency in consultation with GIPCL's/ Owner's representative to carry out laboratory test prior to issuance of material dispatch clearance certificate (MDCC).
3. All the test expenses such as transportation, obtaining certificates etc. related to PV module



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

testing at laboratory shall be borne by the supplier.

4. Standard packaging process followed by bidder shall be shared with Owner prior to signing the contract agreement. In case of any modification suggested by third party inspecting agency, the same shall be incorporated by the bidder.
5. All above tests to be carried out as per agreed schedule.
6. Reference cell or module shall be calibrated in compliance with IEC specification and tender specification prior to manufacturing of each batch.
7. The following standard to be complied by the supplier's related to sampling procedure and safety of the PV module.
  - i. IS 2500 (Part 1): 2000– Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
  - ii. IS 14286: 2010 – Crystalline Silicon – Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval, (First Revision) or any other latest revisions as applicable for ALMM / BIS Approvals
  - iii. IS/IEC 617302004 – Photovoltaic (PV) Module Safety Qualification, Part 1: Requirements for Construction or any other latest revisions as applicable for ALMM / BIS Approvals
8. The supplier shall propose the schedule for pre-dispatch inspection of finished goods to Owner/ GIPCL well in advance, and in no case less than fifteen (15) days prior to commencement of inspection.

#### **4.5. LABELLING AND NAME PLATE REQUIREMENT**

##### **Labelling Requirement:**

All PV modules shall be classified prior to their packing at the manufacturer's workplace to reduce the mismatch losses by sorting on basis of power bin and current bin positivity.

The manufacturer shall paste labels of colors red, yellow and green on the side frames of modules to differentiate between the tolerance values high, medium and low apart from usual labels "H", "M" and "L". This will help the site execution team to segregate the modules faster and connect modules with same tolerance in almost each string.

##### **Name Plate Requirement:**

All individual modules shall be provided with name plate label at the back of module which shall provide the information given below for identification. They shall be clearly visible and shall not



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

be hidden by equipment wiring. Type of labels and fixing of labels shall be such that they are not likely to peel off/ fall off during the life of the PV module.

- i. Manufacturer's name
- ii. Model number and serial number
- iii. Overall dimensions (W x L x D)
- iv. Weight
- v. Maximum power ( $P_{MAX}$ ), voltage ( $V_{MP}$ ) and current ( $I_{MP}$ )
- vi. Short circuit current ( $I_{sc}$ ) and open circuit voltage ( $V_{oc}$ )
- vii. Main system voltage
- viii. Relevant standards and certification laboratory name.
- ix. GIPCL Logo on the top corner of each Module (Design shall be provided to successful Bidder during detail engineering).
- x. Warnings, if any

**4.6. INSURANCE REQUIREMENT**

- a) The Bidder shall quote the price including insurance charges for delivery of the panels from manufacturing plant till the project site. The insurance shall cover against any breakage, damages during loading, transportation, transshipment, and handling.
- b) Bidder shall ensure the registration of the project and the serial no. of PV modules supplied for this project in their insurance coverage scheme to ensure that the buyer can get the insurance cover at times of necessity.
- c) Bidder shall submit the proof of such registration immediately after each lot of dispatch of materials.

**4.7. INSTALLATION REQUIREMENTS**

Module installation shall be carried out by qualified personal and as per manufacturer recommendations. However, PV module shall have the following requirements. This is mainly based on certain site and/ or project specific aspects.

- a) In a string, PV module may be physically connected in different configuration(s)/ arrangement(s).
- b) PV module shall be installed with mounting holes using nut-bolt/ clamping arrangement. In case of nut-bolt arrangement, at least 4 points of connection are required between each module and the mounting surface.
- c) Grounding holes shall be provided for all PV module (framed module).



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

- d) PV modules must be compatible for robotic cleaning. Bidder shall certify the PV module suitable to be cleaned by any type of robotic cleaning system. Any deviation in quality and performance of PV module shall be the responsibility of bidder and bidder shall take all necessary corrective action to replenish the performance and replace the poor-quality materials with new one.

Bidder shall be provided module installation manual to the Owner prior to signing the final contract agreement.

#### **4.8. RFID REQUIREMENTS**

##### **Identification and Traceability:**

Each PV module must use a radio frequency identification (RFID) tag. This can be inside or outside the laminate but must be able to withstand harsh environmental conditions and last the lifetime of the solar module as per latest MNRE norms. The following information must be mentioned in the RFID used on each module.

1. Name of the manufacturer of the PV module
2. Name of the manufacturer of solar cell
3. Month and year of the manufacture (separately for solar cells and modules)
4. Country of origin (separately for solar cell and module)
5. I-V curve for the module at STC (1000 W/m<sup>2</sup>, AM 1.5, 25°C)
6. Wattage, I<sub>m</sub>, V<sub>m</sub> and FF for the PV module
7. Unique serial no. and model no. of the PV module
8. Date and year of obtaining IEC PV module qualification certificate
9. Name of the test lab issuing IEC certificate
10. Other relevant information on traceability of solar cells and module as per ISO 9001.

Site owners would be required to maintain accessibility to the list of module IDs along with the above parametric data for each module.

One number RFID reader must be supplied for each upto 50 MWp by the bidders which are to be compatible to read the data from the RFID tag and download the data to computer. All associated software and cables are to be provided along with the RFID reader.

#### **4.9. GUARANTEE AND WARRANTY**

Bidder shall submit the guarantee and warranty as per Table 3.



**SCOPE OF WORK & TECHNICAL SPECIFICATIONS**

**Table 4: Guarantee and Warranty**

Sl. No.	Item	Unit	Technical Requirements	Bidder's Data *
1.	<b>Module efficiency</b>			
a)	Guaranteed efficiency @ STC	%	20% (minimum)	
2.	<b>Performance data</b>			
a)	Performance warranty	Year	25	
b)	Power warranty	%	Each solar PV module should carry a performance warranty of > 90% during the first 10 years and >80% during the next 15 years.	
c)	Module power output tolerance	W	0 W to (+) 4.99 Wp, negative tolerance is strictly not allowed.	
d)	Degradation curve	-	25 years (annual degradation curve shall be provided)	
3.	<b>Guaranteed degradation (year basis)</b>			
a)	First year (including LID)	%	<3.0	
b)	Second year to 25 <sup>th</sup> year	%	<0.7	
4.	<b>Material warranty</b>			
a)	Product warranty (defects in materials and workmanship)	Year	12	

**5.0. DATA TO BE FURNISHED ALONG WITH THE BID**

- a) All required details to be filled by bidder as per Table 1, Table 2, and Table 4.
- b) Module data sheet
- c) PAN file for module (certified by a third party)
- d) IEC test certificates
- e) Module installation manual
- f) BoM elaborating on the properties, such as, thickness, material composition etc. of the major components of the module which shall be the same as per the type tested and approved constructional data form (CDF).