



सत्यमेव जयते

**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**

भारत सरकार  
रेल मंत्रालय

**GRID CONNECT SOLAR GENERATING SYSTEM  
OF CAPACITY 10 KWp to 500 KWp**

10 से 500 कि.वा. पॉवर क्षमता के ग्रिड संयोजित  
ऊर्जा उत्पादन प्रणाली हेतु विशिष्टि


**Specification No. RDSO/PE/SPEC/PS/0092-2008 (Rev. '0'), Amdt. 5**  
विशिष्टि सं० : आरडीएसओ/पीई/स्पेक/पीएस/0092-2008 (रिवी.'0') अमेन्डमेंट-5

S. N.	Amendment		Revision		Reason
	No.	Date	No.	Date	
1.	1 <sup>st</sup>	19.02.09	-	-	Annexure-A modified as per Rly. Bd's letter no. 2002/ Elect (G) / 150/Ptdt 30.12.2008
2.	2 <sup>nd</sup>	13.05.09	-	-	Annexure 'A' modified as per Railway Board No. letter no. 2002/Elect.(G)/150/9/Pt dated 31.03.2009
3.	3 <sup>rd</sup>	27.09.10	-	-	Added clause 3.0 in Annexure 'B'. Modification by additions/deletions in Clause nos. 1.0, 3.0, 5.4, 6.1, 6.9.1, 6.9.2, 6.9.4, 6.9.5, 6.9.6, 6.9.9, 6.9.13, 6.12.1, 6.12.7, 6.12.14, 6.15, 6.17. Clause No. 10.0 (Guarantee/ Warranty) and Annexure 'A' (Eligibility Criterion for Bidding) deleted as per Railway Board's letter No. 2006/Elect.(G)/150/9/Pt. dated 10.09.2010.
4.	4 <sup>th</sup>	12.10.12	-	-	Added clauses 5.8, 5.9, 5.10, 6.9.16, 6.9.17, 6.9.18, 6.12.17, 6.12.18, 6.12.19, 6.12.20, 6.12.21, 6.12.22, 6.12.23, 6.12.24, 6.12.25, 6.12.26, 6.12.27, 6.12.28, 6.13.3, 6.13.4, 6.13.5, 6.17.1, 6.17.2,13, Annexure C and Annexure D. Deleted clause nos. 6.9.14, 6.10.11, 6.10.12, 6.10.13, 6.11, 6.12.3 and 6.12.14. Modification by additions/deletions in cover page and clause nos. 1.0, 2.0, 3.0, 4.0, 4.2, 4.3, 4.4, 4.5, 4.6, 5.1, 5.2, 5.3, 5.4, 5.6, 6.1, 6.2, 6.4, 6.7.1, 6.7.2, 6.7.3, 6.7.4, 6.8, 6.9.1, 6.9.10, 6.9.12, 6.9.13, 6.10.3, 6.10.4, 6.10.5, 6.10.6, 6.10.8, 6.10.9, 6.10.10, 6.12, 6.12.1, 6.12.2, 6.12.4, 6.12.5, 6.12.6, 6.12.7, 6.12.9, 6.12.10, 6.12.15, 6.12.16, 6.12.17, 6.12.18, 6.13, 6.15, 6.17, 6.18, 9.0 and annexure-B.
5.	5 <sup>th</sup>	19.08.13	-	-	Added clauses no. 5.3, 6.15(vii) Deleted clause no. 7.2, 7.3, 7.4 Modification by additions/deletions in cover page and clauses nos. 2.0, 4.3, 4.4, 5.1, 5.2, 5.3, 5.4, 5.9, 6.1, 6.3, 6.5, 6.7.2, 6.7.3, 6.10.2, 6.10.3, 6.10.7, 6.10.8, 6.12, 6.12.4, 6.12.5, 6.12.17, 6.12.27, 6.15, 6.18, 7.0, 12.0 and Annexure-C

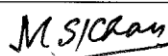

जारीकर्ता  
ऊर्जा प्रबन्धन निदेशालय  
अनुसंधान अभिकल्प एवं मानक संगठन  
मानक नगर, लखनऊ-226011

**ISSUED BY**  
**ENERGY MANAGEMENT DIRECTORATE**  
**RESEARCH DESIGNS AND STANDARDS ORGANISATION**  
**MANAK NAGAR, LUCKNOW- 226011**

**Approved by:**

  
19-08-2013

**Executive Director/(EM)**

Prepared by		SSE/EM	Issued by		DIR (EM)
-------------	-------------------------------------------------------------------------------------	--------	-----------	---------------------------------------------------------------------------------------	----------

**I N D E X**

<b>S. No.</b>	<b>DESCRIPTION</b>	<b>PAGE NO.</b>
<b>1.0</b>	Foreword	3
<b>2.0</b>	Scope	3
<b>3.0</b>	Reference Standards	3
<b>4.0</b>	System Description	4
<b>5.0</b>	General Requirements	5
<b>6.0</b>	Technical Requirements	7
<b>7.0</b>	Installation & Commissioning	19
<b>8.0</b>	Documentation	20
<b>9.0</b>	After Sales Service	20
<b>10.0</b>	Guarantee/Warranty (Deleted)	20
<b>11.0</b>	Log Books	20
<b>12.0</b>	Annual Maintenance Contract	20
<b>13.0</b>	Test	20
	Annexure 'A' (deleted)	25
	Annexure 'B'	25
	Annexure 'C'	28
	Annexure 'D'	29

Prepared by

*M. S. Chavan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

## SPECIFICATION FOR GRID CONNECT SOLAR GENERATING SYSTEM OF CAPACITY 10 KW<sub>p</sub> TO 500 KW<sub>p</sub>

### 1.0 FOREWORD:

Government of India is laying great emphasis on reducing the country's carbon footprint. In this pursuance, the Hon'ble Prime Minister of India has on 30th June, 2008 released the National Action Plan for Climate Change (NAPCC). One of the NAPCC missions is the *National Solar Mission* and it aims to increase the share of solar energy in India's overall energy mix. Accordingly, Indian Railways accords high priority to harnessing of solar energy.

The energy generated by grid connect solar photovoltaic system will be utilized to feed railways' electrical loads during daytime. As a result, during daytime, the purchase of electricity from the electricity authority will get reduced.

### 2.0 SCOPE:

This specification provides the generic requirement for grid connect solar photovoltaic (SPV) system capacities in the range 10 KW<sub>p</sub> to 500 KW<sub>p</sub>. The user will specify the SPV system's KW<sub>p</sub> capacity, after duly considering the MNRE norms for subsidy, electrical load and availability of space for installation of SPV modules. In instances where none of the standard available Power conditioning unit (PCU) KVA ratings are commensurate with the purchaser specified KW<sub>p</sub> of SPV system, in such case the purchaser can consider accepting the PCU of next higher standard rating.

The specification covers general and technical requirements for design, manufacturing, testing, supply, installation and commissioning of Grid connect solar generating system to be provided at railway premises for meeting the railway requirements of lighting, ventilation and other electrical services. The solar photovoltaic generating system's inverter will operate in parallel with the general electric supply system on railway premises.

### 3.0 REFERENCE STANDARDS:

IS: 12834:1989 (reaffirmed 2000)	Solar Photovoltaic Energy Systems – Terminology
IEC : 61215 Ed 2 or latest	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

Prepared by	<u>M. S. Chavan</u> SSE/EM	Issued by	<u>[Signature]</u> DIR (EM)
-------------	-------------------------------	-----------	--------------------------------

IEC: 61730 Pt 1 & 2	Photovoltaic (PV) module safety qualification -Part 1: Requirements for construction Part 2: Requirements for testing
IEC: 61701	Salt mist corrosion testing of photovoltaic (PV) modules
IEC:60904-1(2006)	Photovoltaic Devices- Part-I: Measurement of Photovoltaic current-Voltage Characteristic
IS: 9000	Basic environmental testing procedure for Electronic and electrical items.
IEC:60068	Environmental testing
IEC 61723 Ed1.0	Safety Guidelines for grid connected photovoltaic systems mounted on the buildings
IEC 60364-7-712 (2002)	Electrical Installations of Buildings Part 7: requirements for special installations or locations Section, 712: Photovoltaic power supply systems.
IEC 62446 (2009)	Grid connected photovoltaic systems- Minimum requirements for system documentation, commissioning tests and inspection

**Note:** Normally latest version of the standards shall be referred to.

#### 4.0 SYSTEM DESCRIPTION:

4.1 Solar Photovoltaic (SPV) grid connect system shall consist of mainly the following: -

- i) Solar panels
- ii) Module mounting structure
- iii) Junction boxes
- iv) Power conditioning unit (PCU)
- v) Import & Export metering
- vi) Cable and other accessories

4.2 The PV array converts the light energy of the sun to DC power. The module mounting structure shall be used to hold the module in position. The DC power shall be converted to AC by PCU to supply AC loads such as computers, lights, fans, etc. within the railway premises. Solar power shall be integrated with the premises power supply from electricity authority.


- 4.3 DC distribution board/ combiner shall be provided in between solar array and PCU. It shall have DC Disconnect/MCCB of suitable rating for connection and disconnection of array section. Type II Surge Arrestor should be incorporated for surge protection. It shall have meters for measuring the array voltage and array current. Appropriate IP protection shall be provided. In case of string inverters, if the requirements served by DC distribution board are fully taken care of by string inverter(s), then firms' proposal (if any) for elimination of DC distribution board from the system design, can be considered.
- 4.4 AC distribution board shall be provided in between PCU and loads. It shall have an integrated energy meter, voltmeter and ammeter. As for energy, generally the parameter of interest shall be the aggregate energy output of inverter(s) fed into the individual AC distribution board(s). Though not mandatory, firms are however encouraged to also offer the facility for recording the energy output data of each inverter (wherever multiple inverters are feeding into an AC distribution board). Class I + II (as per IEC 62305) 100 kA Surge Arrestor should be incorporated for protection against surges.
- 4.5 No electrical storage batteries shall be required and accordingly, these are not included in the scope of work.
- 4.6 The system shall comply IEC 60364-7-712 and 62446.

**5.0 GENERAL REQUIREMENTS:**

- 5.1 Solar generating system shall supply part/ full load of railway service buildings/ areas. Thereby, the PV system shall reduce the electric energy units drawn by railway from the grid and reduce IR's CO2 emissions.
- 5.2 Solar panels and array junction boxes shall be installed on shade free roof while the transformer based PCU and distribution boards, etc. shall be housed inside the room provided by Railways. In case of string inverters, railways should carefully weigh the option of indoor vs. outdoor installation. The installation of SPV modules on roof-tops must not impact the waterproofing of the existing terrace structure. The contractor shall be responsible for restoring the waterproofing to its original condition and for provision of additional waterproofing in the areas where RCC blocks are secured on to the terrace. Even though roof-top mounting of solar panels shall be the preferred option, if necessary, railways can at their option specify a ground mounted solar system for part or full system KWp capacity. In the event that railways decide on a ground mounted solar system, they must specifically mention this in their tender and also specify the fencing requirements as will be appropriate to the site (ref. item 6 of Annexure - C). For ground mounted solar systems, railways may need to: carry out site preparation works (e.g. site levelling, removal of obstructions, etc.); plan

suitable arrangements for preventing theft, vandalism, etc.; ensure the availability of adequate railway base load; identify a reliable railway grid power supply line and be responsible for carrying out any supplementary works required for feeding the renewable energy into the identified railway grid power supply line.

- 5.3 For individual systems above 20KWp, availability of requisite space on a single roof-top can at times become a constraint. In such case, the system's overall KWp capacity can be distributed across multiple roof-tops and each of the rooftops shall then feed to the grid power supply system. In works involving such distributed systems, the purchaser must mention the KWp of individual constituent solar systems in the tender (refer item 7 of Annexure - C). If the purchaser does not mention anything against item 7 of Annexure - C, it will be deemed that adequate space is available on a single rooftop for the entire KWp capacity of the system.
- 5.4 If required, statutory approval of local authorities/state electricity distribution company, etc. shall be obtained by the Railway Authority. An export meter (for recording the number of units exported to the grid), if required, shall be either installed by state electricity distribution company or else the respective Railway Authority may include the same in their scope of work. Export metering will be an optional item; it will be specifically mentioned by purchaser, if the same is required to be within the contractor's scope of supply (see Annex C item 5). It is emphasized here, that primary purpose of installing the SPV system covered by this spec., is to meet railway's own energy requirement, rather than supplying renewable energy to the public grid.
- 5.5 Railway Authority shall provide a shadow free area @ 125 - 150 sq. ft./KWp of solar array.
- 5.6 Array structure of PV yard and all electrical equipments such as PCU, inverters, etc. shall be grounded properly. Towards this end, the contractor will supply and install an adequate number and appropriate size of IS:3043 - 1987 compliant earthing kits; at least one each for AC circuit, DC circuit and lighting protection system.
- 5.7 Suitable marking shall be provided on the bus for easy identification.
- 5.8 PV modules may be connected in series up to the maximum allowed operating voltage of the PV modules and the PV inverter, whichever is lower.
- 5.9 The reverse current of blocking diodes (connected in series), if required/ provided, shall be rated for 2 X  $V_{oc\ src}$  of the PV string.
- 5.10 Proper sealing arrangements at the points of cables entering the enclosures/ buildings should be incorporated. Although not mandatory,

Prepared by	<u>M. SICRAN</u>	SSE/EM	Issued by		DIR (EM)
-------------	------------------	--------	-----------	---------------------------------------------------------------------------------------	----------

manufacturers are however encouraged that the cables entering into the enclosures be sealed with modular EPDM based cable sealing and protection system based on multi-diameter technology.

## 6.0 TECHNICAL REQUIREMENTS:

- 6.1 The DC output from the modules shall be fed to array junction box and the strings are paralleled at sub Main & Main junction boxes. Then PCU shall convert DC energy produced by the solar array to AC energy. The AC power output of the inverter shall be fed to the AC distribution board (metering panel & isolation panel), which also houses the energy meter. The AC output of grid-connect SPV system should be paralleled with railway's general electric power supply i.e.the power supply received from the electricity authority.
- 6.2 The system shall automatically wake-up in the morning and supply power, provided there is sufficient solar energy and the grid voltage and frequency are in range.
- 6.3 When the grid voltage and/or frequency go out of preset range, the inverter shall be immediately disconnected from the grid. The inverter will reconnect after a pre-determined time when the grid is back in the range.
- 6.4 Array to inverter voltage drop shall be less than 3% at the maximum power output of the array.
- 6.5 Railways shall provide adequate space and ventilation for the inverter. If string inverters are used, these can be installed below the solar array.
- 6.6 For safety reasons, PV inverter system shall be disconnected from the network following a fault or loss of supply on the power network.
- 6.7 The performance and generation data shall be recorded using a data logger. The monitoring system shall comprise of the following main components:
- 6.7.1 **PCU** will log the inverter performance data and transmit the same to the data logger. It shall also monitor basic parameters like power generated, etc.
- 6.7.2 **Data logger** shall gather information and monitor the performance of the inverter. It shall also support measurements from the external sensors. Data Logger shall also monitor the Solar Insolation and Temp of Array Yard. RDSO and the concerned railway shall be afforded free of cost facility for viewing the system performance data on the manufacturer's or system integrator's or railway's web portal for until the contractual warranty period of the system. It is advisable that the facility of web based system monitoring should continue even after

Prepared by

*M. SICRAN*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

completion of warranty period. After the warranty period, the web based monitoring facility shall be available as a part of AMC, if any (see Cl. 12.0). Else, if the railway desires to enter into a separate new agreement with the contractor solely for post-warranty web based monitoring for a specified period, then it should provide for the same in special condition of tender and ask the tenderers to quote for the same (refer item 8 of Annexure-C).

**6.7.3 Data logging system/software** shall enable automatic long-term storage of measured data from PV plant. It shall allow visualization, monitoring, commissioning and service of the installation. The data logger shall be web enabled. It should be possible to access the data logger with any standard web browser like internet explorer, google chrome, etc. and for this purpose, relevant software/ hardware will be supplied by the contractor. In addition to the web portal, it should also be possible to retrieve the data directly from the data logger. The software for access/ visualization of data from data logger should also be provided by the supplier. Necessary executable files, if any, will be required to be given free of cost by the supplier on a CD/ any other storage device.

#### **6.7.4 Communication interface**

The system should offer RS232/RS485 port and LAN/ WAN interface to facilitate remote monitoring of the system.

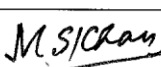

#### **6.8 Sizing of the SPV system**

Sizing of the system should be decided on the basis of railway's electrical load requirement and the availability of space for installation of SPV system.


#### **6.9 SPV Module**

**6.9.1** Individual Solar PV Module should be of minimum capacity 230 Wp conforming to IEC:61215 Ed 2 or latest, IEC : 61730 – I :2007, IEC : 61730 – II : 2007, manufactured in a plant certified under ISO 9001 : 2008 and type tested by an accredited national/international testing laboratory. The Solar PV Module should be made from mono/poly crystalline Silicon Solar Cell connected in series. Imported SPV module or cell will not be accepted, unless MNRE's policy/ rules permit the same. PV modules to be used in a highly corrosive atmosphere (coastal areas, etc.) must qualify Salt Mist Corrosion Testing as per IEC 61701; this compliance and certification will not be required, unless the purchaser specifically asks for the same. Cut cells should not be used (see Annex C, item 2).

**6.9.2** SPV modules of similar output with +5Wp tolerance in single string shall be employed to avoid array mismatch losses.

Prepared by	 SSE/EM	Issued by	 DIR (EM)
-------------	-----------------------------------------------------------------------------------------------	-----------	---------------------------------------------------------------------------------------------------

- 6.9.3 SPV module shall contain crystalline high power silicon solar cells. The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.
- 6.9.4 Photo-electric conversion efficiency of SPV module shall not be less than 14%.
- 6.9.5 Fill factor of the module shall not be less than 72%.
- 6.9.6 Each module shall have low iron tempered glass front for strength and superior light transmission. It shall also have tough multi-layered polymer back sheet for environmental protection against moisture and provide high voltage electrical insulation. Transmittivity of glass shall not be less than 91%.
- 6.9.7 Module junction box and terminal block (weather resistant) shall be designed for long life outdoor operation in harsh environment.
- 6.9.8 Bird spike shall be provided so as to avoid bird sitting on the solar modules at the highest point of the array/module structure.
- 6.9.9 SPV module shall be highly reliable, light weight and shall have a service life of more than 25 years. SPV modules shall have a limited power loss of not more than 10% of nominal output at the end of 10 years and of not more than 20% of nominal output at the end of 25 years.
- 6.9.10 The output of any supplied module shall not be less than the rated output and shall not exceed the rated power by more than 5Wp. Each module, therefore, has to be tested and rating displayed.
- 6.9.11 Whenever more than one module is required, identical modules shall be used.
- 6.9.12 The module shall perform satisfactorily in relative humidity upto 95% and temperature between -10°C and +85°C.
- 6.9.13 The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of solar modules. The terminal block shall be preferably of Noryl rubber with weatherproof design (min. IP 65) and shall have a provision for opening /replacing the cables if required.
- 6.9.14 **Deleted**

Prepared by	<u>M. SICRAN</u>	SSE/EM	Issued by		DIR (EM)
-------------	------------------	--------	-----------	---------------------------------------------------------------------------------------	----------

### 6.9.15 Marking

Each module shall carry the following clear and indelible markings:-

- i) Name, monogram or symbol of manufacturer
- ii) Type or model number
- iii) Serial number
- iv) Polarity of terminals or leads (colour coding is permissible)
- v) Open – circuit voltage
- vi) Operating voltage
- vii) Maximum system voltage for which the module is suitable
- viii) Operating current
- ix) Short circuit current
- x) Date & place of manufacture
- xi) Weight of the module
- xii) Module  $W_p$  tolerance (if it is cumbersome to supply this marking, then this marking can be left out)

6.9.16 Each PV module must use a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.

- i) Name of the manufacturer of PV Module
- ii) Name of the Manufacturer of Solar cells
- iii) Month and year of the manufacture (separately for solar cells and module)
- iv) Country of origin (separately for solar cells and module)
- v) I-V curve for the module
- vi) Peak Wattage,  $I_m$ ,  $V_m$  and FF for the module
- vii) Unique Serial No and Model No of the module
- viii) Date and year of obtaining IEC PV module qualification certificate
- ix) Name of the test lab issuing IEC certificate
- x) Other relevant information on traceability of solar cells and modules as per ISO 9000 series


6.9.17 Modules shall be tested as per clause-13.1.

6.9.18 Insulation Resistance of the module shall not be less than 50M-ohm when measured with a 500V DC megger.

### 6.10 Module Mounting Structure

6.10.1 The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels.

6.10.2 The structure shall be designed to allow easy replacement of any module by authorized personnel and shall be in line with the site requirements.

Prepared by	<u>M. SICRAJ</u>	SSE/EM	Issued by		DIR (EM)
-------------	------------------	--------	-----------	---------------------------------------------------------------------------------------	----------

- 6.10.3 The array structure shall be made of hot dipped galvanized MS angles (or alternate MS sections) of suitable size. Galvanization thickness shall be of min. 85µm. If the systems are installed in coastal/ corrosive areas, the minimum galvanization thickness of array structure shall be 120µm. Unless the purchaser has specifically asked for 120 µm thickness, normally 85 µm will be supplied (see Annex C item 3).
- 6.10.4 The foundation for module mounting structure shall be preferably 1:2:4 RCC construction or any other combination based on the local site condition requirement for which design details shall be submitted.
- 6.10.5 The support structure, design and foundation shall normally be designed to withstand wind speed upto 150 kmph. In coastal/ high wind areas, the support structure, design and foundation shall be designed to withstand wind speed upto 200 kmph. If the purchaser does not specify anything to the contrary, then 150 kmph wind withstanding capability shall be provided (Refer item 4 of Annexure-C).
- 6.10.6 The clearance between lowest part of the module structure and the developed ground level shall normally not be less than 500mm. However, in exceptional cases, lower clearances may be allowed on case to case basis.
- 6.10.7 The module alignment and tilt angle shall be calculated to provide the maximum annual energy output. This shall be decided based on the location of array installation. The SPV panel shall have a provision for angular adjustment of the mounting structure to get maximum utilization of incident sunlight. It shall be mounted facing south and tilted to an angle equal to the latitude (where being used), for optimum performance.
- 6.10.8 Generally, fasteners shall be of stainless steel SS304. To prevent pilferage, anti-theft fasteners shall be provided at appropriate locations.
- 6.10.9 **Junction Boxes**
- i) The module junction box (if any) shall be certified as per IEC 61215. Else, they should have the same properties as mentioned for array junction boxes. Array sub-main and main junction boxes, shall have the following properties:
- a. They shall be dust, vermin & waterproof and made of Polycarbonate-Glass Fibre Substance (PC-GFS) thermoplastic. The enclosure should be double insulated with protection class II as per IEC 61439-1. Material and the protection class shall be marked on the enclosure.
- b. The enclosure shall have a transparent front lid for enabling easy visibility.

- c. The enclosures shall have IP 65/66 protection in accordance with IEC 60529. Third party conformance certificate is required to be given for IP 65/ IP 66 degree of protection.
- d. Minimum requirements for fire protection in the event of internal faults: Glow wire test in accordance with IEC 60 695-2-11 at 960°C for box and 850°C for conducting components.
- e. Burning Behavior: Base part of Polycarbonate Enclosure shall be UL94-V-0 compliant and Lid part of PC Enclosure shall be UL94-V-2 compliant.
- f. The enclosures shall have IK 08 degree of protection for mechanical load.
- g. The material used shall be halogen, silicon free conforming to RoHS directive 2002/95/EC.
- h. The enclosure shall have a usage temperature rating of -10°C to 55°C.
- i. The enclosure should be chemically resistant to acid, lye, petrol, mineral oil & partially resistant to benzene.
- j. The enclosures shall have a rated insulated voltage of 1000V DC and dielectric strength of 4.65 KV DC.
- k. The material of the enclosure shall be UV stabilized.
- l. Though not mandatory, manufacturers are encouraged to provide breather glands in the array junction boxes to prevent overheating and explosions.

Unless otherwise stipulated, the properties mentioned above should be demonstrated through datasheet of the manufacturer.

- ii) SPDs Class II as per IEC 61643-1, shall be used at the terminals of array junction boxes for external surge protection. Internal Surge protection (SPDs) shall consist of three MOV type arrestors connected from + ve and – ve terminal to earth (Via Y arrangement) for higher withstand of the continuous PV-DC voltage during earth fault condition. SPD shall have safe disconnection & short circuit interruption arrangement through integrated DC in-built bypass fuse (parallel) which should get tripped during failure mode of MOV, extinguishing DC arc safely (created by inbuilt thermal disconnection) in order to protect the installation against fire hazards. Nominal discharge current ( $I_n$ ) at 8/ 20 microseconds shall be minimum 10 KA with maximum discharge current ( $I_{max}$ ) of minimum 20 KA at 8/20 microseconds with visual indication (through mechanical flag) in all modules to monitor the life of SPD. The  $I_{scpv}$  (Short Circuit current withstand capacity of arrester) would be at least 10% more than Nominal output current of the combiner box and AJB. Detailed internal schematic for the above SPDs, compliant to these specifications, should be submitted by the manufacturers.

Prepared by

M. S. Khan

SSE/EM

Issued by



DIR (EM)


- iii) The junction boxes shall have suitable cable entry points with cable glands of appropriate sizes for both incoming and outgoing cables. Though not mandatory, manufacturers are encouraged to provide suitable cable entry points fitted with MC-4 Connectors.
- iv) Suitable markings should be provided on the bus bar for easy identification, and cable ferrules shall be fitted at the cable termination points for identification.
- v) The Array Junction Box should preferably have maximum 08 input and 01 output with SPD and Terminal block.

#### 6.10.10 **Earthing for PV array, Balance of System (BOS), lightning protection and other components.**

- i) The photovoltaic modules, Balance of system (BOS) and other components of power plant require proper grounding for protection against any serious faults as guided by IEC 60364.
- ii) The earthing resistance must not exceed the limits generally in practice for such applications.
- iii) The Bidder shall submit the detailed scheme of earthing and grounding.
- iv) The contractor will supply and install an adequate number and appropriate size of IS:3043 – 1987 compliant earthing kits; at least one each for AC circuit, DC circuit and lightning protection system.
- v) The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the overvoltage to a tolerable level before it reaches the PV or other sub-system components. Lightning protection should be provided as per IEC 62305.
- vi) Necessary concrete foundation or any other arrangement for holding the lightning conductor in position is to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.
- vii) The lightning conductor and structures shall be earthed through flats as per applicable Indian Standards with earth pits. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure. Else, a matrix of lightning conductors is to be created which will be required to be connected to an earth.
- viii) If necessary, more numbers of lightning conductors may be provided.
- ix) The Bidder shall submit the drawings and detailed specifications of the PV array lightning protection equipment.

6.10.11 **Deleted**

6.10.12 **Deleted**

Prepared by	<u>M. SICRAN</u> SSE/EM	Issued by	 DIR (EM)
-------------	----------------------------	-----------	---------------------------------------------------------------------------------------------------

**6.10.13 Deleted****6.11 Deleted****6.12 Power Conditioning Unit (PCU)**

PCU shall supply the DC energy produced by array to DC bus for inverting to AC voltage using its MPPT (Maximum Power Point Tracking) control to extract maximum energy from solar array and produce 415V (+15% and -20%) AC, 3 phase, 50 ± 5% Hz (47.5 to 52.5 Hz) to synchronize with the local grid. For sizing of grid connect inverter, the general guideline will be that the ratio of SPV KWp rating to inverter's KVA rating shall be within 1.15. The array output should be well within the input voltage range of the inverter so that the inverter works in MPPT range for most of the solar insolation range. This should be applicable for the whole life of the solar array and needs to be substantiated through design calculations. PCU should be able to handle maximum open circuit DC voltage of 1,000V.

6.12.1 MPPT controller, inverter and associated control and protection devices, etc. all shall be integrated into the PCU.

6.12.2 PCU/ string inverter shall provide 3 phase, 415V (with grid tracking of +15%/-20%), 50 Hz (with grid tracking of ±5% i.e. 47.5 to 52.5 Hz) supply on AC side with voltage THD of less than 3% and current THD of less than 5%.

**6.12.3 Deleted**

6.12.4 Efficiency of PCU with transformer shall not be less than 92% for systems from 10KWp to less than 30 KWp, 93% for systems from 30KWp to less than 50KWp and 94% for systems greater than or equal to 50KWp. For transformer-less design, it shall be minimum 96%.

6.12.5 Degree of protection will be minimum IP20 for non-electronics portion where transformer, etc. are mounted, if any and for the rest of the portion including electronics, it will be IP31 for units of capacities upto 15KWp and IP41 for units of capacities greater than 15KWp. For inverters to be installed outdoors, IP65 protection shall be required. In future, RDSO will actively consider upgrading the requirement of IP protection, keeping in view the highly dusty environment in Indian subcontinent. Therefore, manufacturers are encouraged to develop even higher IP protected systems for future requirements of IR.

Prepared by

*M. S. Chavan*

SSE/EM

Issued by



DIR (EM)

- 6.12.6 Railways should carefully weigh the option of indoor vs. outdoor location for string inverter.
- 6.12.7 The inverter shall be efficient with IGBT based reliable design. The control system should be of highest reliability preferably based on Digital Signal Processors. Though not mandatory, the manufacturers are encouraged to provide the control system of redundant type.
- 6.12.8 The PCU shall be capable of complete automatic operation, including wake-up, synchronization and shut down.
- 6.12.9 PCU shall have the facility to display the basic parameters of the system on a typical 4 line by 20 characters type LED/LCD display. Displays of a bigger size can also be provided.
- 6.12.10 PCU shall be able to synchronize independently and automatically/ phase-lock with POWER SUPPLY AUTHORITY grid power line frequency to attain synchronization.
- 6.12.11 Built-in data logging to monitor plant performance through external PC shall be provided.
- 6.12.12 Inverter shall be tested for islanding protection performance.
- 6.12.13 Only isolated inverters shall be grounded on DC side.
- 6.12.14 **Deleted**
- 6.12.15 **Indications** (through LEDs/ LCD display)

Following is an indicative list of indications (the actual scheme will be finalized at design stage):

- i) Inverter ON
- ii) Grid ON
- iii) Inverter under voltage/over voltage
- iv) Inverter over-load
- v) Inverter over-temperature
- vi) Earth Fault

6.12.16 **Protections**

Following is an indicative list of protections (the actual scheme will be finalized at design stage):

- i) Over-voltage both at input and output
- ii) Over-current both at input and output
- iii) Over/under grid frequency
- iv) Over temperature

- v) Short circuit on AC side
- vi) Reverse polarity protection
- vii) Array ground fault protection
- viii) Protection against lightning induced surges Class II, 10 kA as per IEC 61643-1
- ix) Protection against surge voltage induced at output due to external source

6.12.17 Night consumption of the PCU shall be less than 0.2% of the rated power of the inverter for system capacities of 25KWp or more. It shall be less than or equal to 50W for system capacities of less than 25KWp.

6.12.18 Noise level of the PCU should be less than 65 dBA (nominal) at 1m.

6.12.19 DC insulation resistance should be more than 50MΩ.

6.12.20 EMI and EMC Requirements:PCU shall comply the following EMI and EMC requirements:

- i) Emitted interference as per IEC: 61000-6-4.
- ii) Interference emitted as per IEC: 61000-6-2.

6.12.21 An integrated earth fault detection device is provided to detect eventual earth fault on DC side and shall send message to the supervisory system.

6.12.22 Idling current at no load shall not exceed 2% of the full load current.

6.12.23 PCU shall withstand high voltage test of 2,000 Vrms between either the input or the output terminals and the cabinet (chassis).

6.12.24 PCU includes ground lugs for equipment and PV array groundings. The DC circuit ground shall be a solid single point ground connection.

6.12.25 Where PCU hasnot been provided with galvanic isolation, a type B residual current device (RCD) according to IEC 60755 amendment 2 shall be installed to provide fault protection by automatic disconnection of supply. Inbuilt RCD will also be accepted.

6.12.26 To allow maintenance of the PCU, means of isolating the PCU from the DC side and the AC side shall be provided.

6.12.27 PCU can be a centralized unit or a combination of multiple string inverters.

6.12.28 The PCU should withstand the environmental tests (as per IEC 60068/ IS 9000) listed below with the PCU working at full load for at least last half an hour. For SPV systems of 10 KWp or higher

Prepared by

*M. S. Khan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

capacity, environmental test results in respect of any similar design PCU for at least 10 KWp SPV systems will be adequate.

- a) Dry Heat Test: 50°C±2°C for 16 hours
- b) Damp Heat Test (Steady state): 40°C, 93% RH for 4 days
- c) Damp Heat Test (Cyclic): 40°C, 93% RH for 6 cycles (duration of one cycle shall be 24hrs)
- d) Cold Test: 0°C for 16 hours
- e) Change of temperature Test: -10°C/-5°C to 50°C for 3 cycles (rate of change in temperature shall be 3°C per minute)

### 6.13 Cables and Hardwares

The cables used in module/ array wiring shall be TUV 2Pfg 1169/08.2007 or VDE EPV 01:2008-02 or UL4703 certified.

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

- i) Temp. Range -10°C to +120°C.
- ii) Voltage rating 600/1000V
- iii) Excellent resistance to heat, cold, water, oil, abrasion, UV radiation, ozone and weathering
- iv) Halogen-free, low smoke, low toxicity.
- v) Flame retardant
- vi) Flexible
- vii) Fulfills IEC 60332-1 requirements. Accredited lab test report/Manufacturer's test report shall be attached.
- viii) Conductor class IEC 60228 class 5. Accredited lab test report/Manufacturer's test report shall be attached.

6.13.1 Cabling on DC side of the system shall be as short as possible to minimize the voltage drop in the wiring.

6.13.2 Components and hardware shall be vandal and theft resistant. All parts shall be corrosion-resistant.

6.13.3 Voltage drop on the DC side from array to the inverter should not be more than 3%. Necessary calculations in this regard shall also be submitted during design approval.

6.13.4 Overload protection may be omitted to PV string and PV array cables when the continuous current-carrying capacity of the cable is equal to or greater than 1.25 times  $I_{sc\ stc}$  at any location. Necessary calculations in this regard shall be submitted during design approval.

Prepared by

*M. S. ICRAN*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

6.13.5 Overload protection may be omitted to PV main cable if the continuous current-carrying capacity of the cable is equal to or greater than 1.25 times  $I_{SC\ STC}$  of the PV generator. Necessary calculations in this regard shall be submitted during design approval.

6.14 The system description, general/technical requirements, etc. are given for general guidance only. The supplier/manufacturer shall submit the detailed design of the complete solar generating system by using their software to optimize the combination of modules considering the specific location, insolation, nature of load, etc.

6.15 **AC Distribution Board (ACDB):**

The ACDB shall be used to terminate single or multiple PCU outputs. The ACDB must have the following features:

- i) Cables connecting bus bar should be minimum 3 times capacity of Solar Power plant.
- ii) Input Grid Line should come from such Distribution Board of client so that the railway load is fed parallelly by the grid as well as SPV system.
- iii) The Solar Power should be exported to the bus bar inside the ACDB through a LCD display Energy Meter. In case the systems are installed on multiple rooftops, then for each individual rooftop system, an independent ACDB shall be generally required.
- iv) The Designated Load should be routed through ACDB and an Energy Meter to register the Load Energy Consumption from Solar and Grid during Week Days and Holiday.
- v) The SPV system will help Railways to obtain GRIHA/ ECBC certification for the buildings.
- vi) ACDB should have Class I + II (as per IEC 62305; IEC 61643 and IEC 60364-5-53), 100 kA Surge Suppression inbuilt for surge protection. Surge protection on AC side (Type 1 + Type 2) shall consist of Pre wired metal encapsulated spark gap based solution for fire safe and fire proof operation at site, consisting of base part and plug in protection modules. Total discharge capacity/ Lightning Impulse current ( $I_{imp}$ ) at 10/350  $\mu$  sec and nominal discharge current ( $I_n$ ) at 8/ 20  $\mu$  sec shall be minimum 100 KA for three phase power supply system and 50 KA for single phase power supply system. The discharge capability of L-N connected module shall be 25 KA at 10/350  $\mu$  sec and 8/20  $\mu$  sec. All the L-N & N-E connected arresters shall have built in mechanical health indication. Complete solution shall have voltage protection level (Up) of  $\leq 1.5$  KV to protect the sensitive electronics inside the

Prepared by

*M. S. Khan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

Invertors, having follow current extinguishing and limiting capability up to 25 KA rms (at 255V) without tripping of even small rating 32 AGL/gG fuse and approved from international independent test labs like KEMA or VDE or UL as per latest IEC 61643-1 or equivalent EN 61643-11 standard. SPDs on the ACDB shall be provided if the same haven't been provided on the PCU.

vii) Appropriate IP protection shall be provided

#### 6.16 Approval of System Design

6.16.1 The concept plan/design of each sub-system shall be submitted to RDSO for approval. The wiring diagram and operation and maintenance information details shall be given as detailed in IEC 62446.

6.16.2 Quality Assurance Plan should include design control, process control, quality control, testing of sub-system, integration and bill of material intended to be used.

#### 6.17 Prototype Testing

6.17.1 RDSO shall conduct prototype testing of Grid connect Solar Generating System of individual capacity separately. For certain tests, the type testing authority i.e. RDSO may choose to rely upon previous type test reports/conformance certificates, as long as they pertain to similar design and are of comparable rating. However, the manufacturer cannot demand this as a matter of right.

6.17.2 Until the railways are able to issue their vendor list, they may in the interim period invite tender/ place order with the provision of accepting the material on the basis of firm's written clause-by-clause confirmation of the spec. and acceptance test alone, wherever this is considered necessary by CEE.

#### 6.18 Cleaning of SPV modules

For the purpose of cleaning of SPV modules, railways shall ensure that the Array Yard is equipped with permanent Water Line, Butterfly valve and rubber hose. During the warranty period, the contractor shall carry out the cleaning of SPV modules, on an average, once in three months; in addition, railway on its part will be responsible to arrange for cleaning of SPV modules once in every two weeks.

### 7.0 INSTALLATION & COMMISSIONING:

The installation shall be done by the supplier/manufacturer who is responsible for system performance, direction of installation and structural stability. The supplier shall conduct a detailed site assessment. The PV installer shall obtain data specific to the site, rather than relying on general data. While making foundation

Prepared by

*M. S. Khan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

design, due consideration shall be given to weight of the module assembly, maximum wind speed at the site, etc.

### **8.0 DOCUMENTATION:**

The supplier shall provide easy-to-use illustrated installation and operation manual in English for easy installation and trouble-free usage. Manual shall contain complete system details such as array layout, schematic of the system, working principle, clear instruction on regular maintenance, trouble-shooting of the solar generating system, emergency shutdown procedure, etc.

### **9.0 AFTER SALES SERVICE:**

The details of service centers in India shall be provided along with the offer. All essential materials and manpower shall be placed at the service centers to ensure quick and efficient after sales service.

### **10.0 GUARANTEE / WARRANTY - (Deleted)**

### **11.0 LOG BOOKS:**

Railways shall maintain a logbook detailing inspection and operating activities. This logbook must be kept in a secure place and shall be made available, whenever required for inspection. Testing of all protection devices shall be carried out at regular intervals (no longer than six months) by the customer and recorded in the logbook.

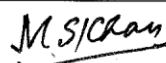
### **12.0 ANNUAL MAINTENANCE CONTRACT:**

The contractor will have to quote the rates for Comprehensive Annual Maintenance Contract (AMC). During the AMC period, the contractor shall also carry out the cleaning of SPV modules, on an average, once in three months; in addition, railway on its part will be responsible to arrange for cleaning of SPV modules once in every two weeks. Further, unless otherwise stipulated by the purchaser in the tender, during the AMC period, the contractor shall also provide web based monitoring facility (as detailed in Cl. 6.7.2).

### **13.0 TESTS:**

The manufacturer shall carry out routine tests at his works and shall maintain records for the same. Acceptance testing shall be carried out by the purchaser or his representative or by any agency deputed by the purchaser on his behalf.

Prepared by



SSE/EM

Issued by



DIR (EM)

**13.1 Test on SPV Module**

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	Refer Annexure B
2.	Design Qualification	√	√	√*	IEC 61215
3.	Safety Qualification	√	√	√*	IEC 61730- I & II
4.	Photo Electrical Conversion Efficiency	√	√	√	By Sun simulator(Refer Cl. 6.9.4)
5.	Fill Factor	√	√	√	By Sun simulator (Refer Cl. 6.9.5)
6.	Transmittivity of Glass	√			Refer Cl. 6.9.6
7.	Rated output of module	√	√	√	By Sun simulator. Refer Cl. 6.9.1
8.	Module mismatch test			√	Refer Cl 6.9.10
9.	Array mismatch test			√	Refer Cl 6.9.2
10.	Encapsulation and sealing	√	√	√	Refer Cl 6.9.13
11.	Terminal block	√	√	√	Refer Cl 6.9.13
12.	Provision of Bird Spike	√		√	Refer Cl 6.9.8
13.	Provision of RFID tag with requisite details	√	√	√	Refer Cl 6.9.16
14.	Environmental tests	√		√**	Refer Annexure B
15.	Provision of Earthing	√		√	Refer Cl 6.10.10
16.	Marking	√	√	√	Refer Cl 6.9.15

\* Copy of the latest conformance certificates should be asked

\*\* If compliance has already been checked during type testing, the same will be relied upon, otherwise compliance will be ensured through physical tests

**13.2 Tests on Module Mounting Structure**

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	

Prepared by

*M. S. Khan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

2.	Dimension	√	√	√	As per manufacturer's data sheet
3.	Design calculation on wind withstand capability	√	√	√	Refer Cl 6.10.5
4.	Clearance between module and ground	√		√	Refer Cl 6.10.6
5.	Galvanization thickness	√	√	√	Refer Cl 6.10.3
6.	Foundation			√	Refer Cl 6.10.4
7.	Provision of Earthing	√		√	Refer Cl. 6.10.10
8.	Fasteners	√		√	Refer Cl. 6.10.8

### 13.3 Tests on module junction box, Array sub-main and main Junction Box

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	Refer Cl 6.10.9(i),(iii), (iv) & (v)
2.	Material	√		√	Refer Cl 6.10.9(i)
3.	IP Protection	√	√	√	Refer Cl 6.10.9(i)
4.	Surge Protection	√	√	√	Refer Cl 6.10.9(ii)
5.	Cable Glands	√	√	√	Refer Cl 6.10.9(iii)

### 13.4 Test on Power Conditioning Unit (PCU)

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	MPPT range	√		√	Refer Cl. 6.12
3.	Voltage Range	√	√	√ <del>£</del>	Refer Cl. 6.12
4.	Frequency range	√	√	√ <del>£</del>	Refer Cl. 6.12
5.	Harmonics on AC side	√	√	√	Refer Cl. 6.12.2
6.	PCU efficiency	√	√	√	Refer Cl. 6.12.4
7.	Protection Tests	√			Refer Cl. 6.12.16
8.	Surge Protection	√ <sup>μ</sup>	√	√ <sup>μ</sup>	Refer Cl. 6.12.16, 6.15(vi)
9.	IP protection	√		√	Refer Cl. 6.12.5
10.	Control Circuit	√			Refer Cl. 6.12.7

Prepared by	<i>M. S. Chavan</i>	SSE/EM	Issued by	<i>[Signature]</i>	DIR (EM)
-------------	---------------------	--------	-----------	--------------------	----------

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
	redundancy				
11.	Automatic operation & synchronization	√	√	√	Refer Cl. 6.12.8, 6.12.10
12.	Islanding Protection	√		√	Refer Cl. 6.12.12
13.	Displaying of basic Parameters on LED/LCD display	√	√	√	Refer Cl. 6.12.9
14.	Data logging, Communication interface and web application	√	√	√	Refer Cl. 6.7
15.	Night Consumption	√		√	Refer Cl. 6.12.17
16.	Noise Level	√			Refer Cl. 6.12.18
17.	Power Factor Measurement	√	√		
18.	Insulation resistance	√	√	√	Refer Cl. 6.12.19
19.	EMI/EMC	√		√ <sup>⊗</sup>	Refer Cl. 6.12.20
20.	Idling current	√	√	√	Refer Cl. 6.12.22
21.	High Voltage test	√			Refer Cl. 6.12.23
22.	Provision of RCD	√	√	√	Refer Cl. 6.12.25
23.	Provision of Isolation	√	√	√	Refer Cl. 6.12.26
24.	Earthing	√	√	√	Refer Cl. 6.12.24, 6.10.10
25.	Environmental Test	√		√ <sup>⊗</sup>	Refer Cl. 6.12.28

⊗ If compliance has already been checked during type testing, the same will be relied upon, otherwise compliance will be ensured through physical tests

<sup>μ</sup> Datasheet of the manufacturer will be relied upon

### 13.5 Tests on Cables

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Temperature range	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(i)
3.	Voltage rating	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(ii)
4.	Resistance to heat, cold, water, oil, abrasion, UV radiation, ozone and weathering	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(iii)
5.	Halogen -free,	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(iv)

Prepared by

*M. S. Chavan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
	Low smoke and Low toxicity				
6.	Flame retardant	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(v)
7.	Flexible	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(vi)
8.	IEC 60332-1 requirements	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Refer Cl 6.13(vii)
9.	IEC 60228 class 5	√ <sup>β</sup>	√ <sup>β</sup>	√ <sup>β</sup>	Ref. Cl 6.13(viii)
10.	Module/ array wiring	√	√	√	Ref. Cl 6.13
11.	Sizing of cable	√	√	√	Ref. Cl 6.13.4, 6.13.5

<sup>β</sup> Manufacturer's data sheet shall be relied upon

### 13.6 Other tests

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	Refer Cl 4.3, 4.4, 6.1,6.15, and 6.16
2.	DCDB	√		√	Refer Cl 4.3
3.	ACDB	√		√	Refer Cl 4.4 and 6.15
4.	Configuration of supply			√	Refer Cl 6.1
5.	System design	√		√	Refer Cl 6.16, 6.13.4, 6.13.5
6.	Data Logger and Web Based Monitoring	√		√	Refer Cl 6.7

Prepared by

*M. S. Chavan*

SSE/EM

Issued by

*[Signature]*

DIR (EM)

**Annexure -A****Eligibility Criterion for Bidding – (Deleted)****Annexure-B****Quality Testing of PV-Module**

Modules used in solar panels shall have IEC 61215 Ed 2 or latest compliance certificate. The qualification testing procedure is defined in IEC 61215 Ed 2 or latest to examine the impact of mechanical, thermal and electrical stress on power output. The bidder shall submit appropriate type approval certificate for the offered solar modules from accredited test laboratory.

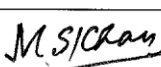

**Method of Testing****1.0 Visual Inspection:**

Each module shall be carefully inspected under an illumination of not less than 1,000 lux for the following conditions:

- 1.1 Racked, bent, misaligned or torn external surfaces.
- 1.2 Broken / cracked cells
- 1.3 Faulty interconnections or joints
- 1.4 Cells touching one another or the frame
- 1.5 Failure of adhesive bonds; bubbles or delaminations forming a continuous path between a cell and edge of the module
- 1.6 Faulty terminations and exposed live electrical parts
- 1.7 Junction box should have common terminals with suitable blocking diode to prevent reverse current flow.

**2.0 Performance at STC: (Clause 10.1 of IEC 61215 Ed 2 or latest)**

The current-voltage characteristics of the module shall be determined in accordance with IEC 60904-1 at a specific set of irradiance and temperature conditions. Performance of PV-Module shall be generally

Prepared by	 SSE/EM	Issued by	 DIR (EM)
-------------	-----------------------------------------------------------------------------------------------	-----------	---------------------------------------------------------------------------------------------------

evaluated at Standard-Test-Conditions (STC) as defined in IEC 60904 standards:

- i) Cell temp. of 25° C,
- ii) Incident solar irradiance of 1000W/m<sup>2</sup>,
- iii) Spectral distribution of light spectrum with an air mass AM=1.5

**3.0** All PV modules supplied shall be accompanied with I-V curves (tested in the manufacturing unit, clearly indicating the serial number, batch number, date and country of origin).

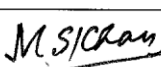

#### **4.0 Environmental Testing:**

Following environmental test shall be conducted on offered module or on module of similar design, for initial clearance of the offered system.

<b>Test</b>	<b>Test Details</b>	<b>Actual test to be carried out at Govt. Recognized Lab or manufacturer premises as per standard</b>
<b>Cold Test</b>	Temp. (-) 10°C Duration: 16 hrs.	IEC-68-2-1
<b>Dry Heat</b>	Temp. (+) 70°C Duration: 16 hrs	IEC-68-2-2
<b>Salt spray*</b>	Temp. (+) 35°C, RH 95% Duration: 2 hrs spray and 22 hrs conditioning No. of Cycle : 01	IEC-68-2-11 Test Ka
<b>Wind</b>	Pressure equivalent to an air velocity of 200 km/hr.	
<b>Rain</b>	Test as required in the mentioned standards	JSS: 55555 (Test No. 12)
<b>Dust</b>	Temp : 40°C, RH < 50% Duration – 1 hr	JSS: 55555 (Test No. 14)
<b>Others</b>	Electrical Isolation test Routine test	Shall be done at manufacturers place for every modules offered

\* If compliance to IEC 61701 has been asked by the purchaser, then this test will not be required.

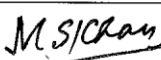

**Note-** Before and after the environmental testing the solar modules shall be subjected to performance test on sun simulator and insulation resistance test, and no degradation of maximum output power shall not exceed 5% of the value measured before the test.

Prepared by	 SSE/EM	Issued by	 DIR (EM)
-------------	-----------------------------------------------------------------------------------------------	-----------	---------------------------------------------------------------------------------------------------

## 5.0 Acceptance Criteria:

The module is deemed to have passed the tests if the sample meets the following criteria:

- 5.1 There is no evidence of a major visual defect such as a cracked or broken window, bubbles or de-lamination in the encapsulant etc.
- 5.2 There is no cell breakage and no water infiltration into terminal boxes.
- 5.3 No sample exhibits any open circuit or ground fault.
- 5.4 No visible evidence of major defects that may affect performance of the module.
- 5.6 Insulation Resistance not less than 50M-ohm at 500 V DC.
- 5.7 Degradation of performance may not exceed 5% after each single test or 8% after the whole sequence.

Prepared by	 SSE/EM	Issued by	 DIR (EM)
-------------	-----------------------------------------------------------------------------------------------	-----------	---------------------------------------------------------------------------------------------------

**Annexure - C****Technical details to be furnished by the purchaser in his tender**

1. System Power Rating (KWp) and place of installation:
2. Is Compliance and certification to salt mist corrosion testing as per IEC 61701 required {Refer Cl. 6.9.1} (Yes/No):
3. Required galvanization thickness (Refer Cl. 6.10.3)
4. Support structure, design and foundation wind withstanding capability required (see Cl. 6.10.5)
5. Is supply of Export Metering required {Refer Cl. 4.1, 5.4} (Yes/No):
6. (a) Is ground mounted solar system required {Refer Cl. 5.2} (Yes/No):  
(b) If the answer to 6(a) is 'yes', then please specify the ground mounted system's KWp capacity, site location and fencing requirements.
7. (a) Will the overall rooftop KWp capacity be distributed across multiple rooftops {Refer Cl. 5.3} (Yes/No):  
(b) If the answer to 7(a) is 'yes', then please give necessary details i.e. KWp distribution on multiple rooftops, inverters, site locations, etc.
8. In what manner does the railway propose to continue to avail of web based monitoring service after the completion of warranty period:  
(a) As a part of AMC services {Cl. 12.0} (Yes/ No); OR  
(b) Through a separate new agreement with the contractor for web based monitoring {Cl. 6.7.2}(Yes/ No)

Note: In the event that the overall KWp capacity (at Sr no. 1) is split between rooftop and ground based installations, the total of KWp capacities in Sr. no. 6 & 7 shall not exceed the overall KWp capacity as indicated at Sr. no. 1

Prepared by	<i>M. S. Khan</i> SSE/EM	Issued by	<i>[Signature]</i> DIR (EM)
-------------	-----------------------------	-----------	--------------------------------

**Annexure-D****Technical data to be furnished by the tenderer in his offer****1. Total Power rating of Solar System**

- a) System power rating(KWp)

**2. Solar Panel**

- a) Make and model no.  
 b) Power rating of the module  
 c) Name of the manufacturer of PV Module  
 d) Name of the Manufacturer of Solar cells  
 e) Country of origin (separately for solar cells and module- Refer Clause 6.9.1)  
 f) Peak Wattage,  $I_m$  and  $V_m$  for the module(Refer Clause 6.9.1)  
 g) Operating voltage of array(Refer Clause 6.12)  
 h) Efficiency of the module(Refer Clause 6.9.4)  
 i) Fill Factor of the module(Refer Clause 6.9.5)  
 j) Variation band of rated output of the module (Refer Clause 6.9.10)  
 k) Galvanization thickness of the module mounting structure (Refer Clause 6.10.3)

**3. Power Conditioning Unit (PCU)**

- a) Make and Model no  
 b) Power rating  
 c) Output voltage and frequency range(Refer Clause 6.12)  
 d) Voltage range of grid synchronization (from nominal)  
 e) Frequency range of grid synchronization (from nominal)  
 f) Communication interfaces offered  
 g) Data communication protocols  
 h) Input voltage range for MPPT operation(Refer Clause 6.12)  
 i) Efficiency(Refer Clause 6.12.4)  
 j) Voltage and Current THD(Refer Clause 6.12.2)  
 k) IP protection(Refer Clause 6.12.5)  
 l) Noise level(Refer Clause 6.12.18)  
 m) Idling current  
 n) Surge protection on DC and AC side  
 o) Name of URL at which the purchaser can view the system performance data (Refer Cl. 6.7.2)

**4. Compliance and certification to salt mist corrosion testing as per IEC61701 {Refer Cl. 6.9.1} (only if the purchaser has asked for this compliance):****5. Details of Export Meter offered {Refer Cl. 5.4} (only if the purchaser has asked for this item):****6. Details of all cables to be supplied by the firm****7. Details of RCD (in case galvanic isolation doesn't exist in PCU)**

-----

Prepared by	<i>M. S. Khan</i> SSE/EM	Issued by	<i>[Signature]</i> DIR (EM)
-------------	-----------------------------	-----------	--------------------------------