



सत्यमेव जयते

भारत सरकार –रेल मंत्रालय
अनुसंधान अभिकल्प एवं मानक संगठन

GOVERNMENT OF INDIA - MINISTRY OF RAILWAYS
RESEARCH DESIGNS AND STANDARDS ORGANISATION

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**SPECIFICATION FOR STAND-ALONE SOLAR PHOTOVOLTAIC LED BASED STREET
LIGHTING SYSTEM**

S N	Amendment		Revision		Reason
	Number	Date	Number	Date.	
1.	1 st	19.02.09	-	-	Annexure-A modified as per Rly Bd's letter no. 2002/Elect(G)/150/Pt dt 30.12.2008
2.	2 nd	14.05.09	-	-	Annexure-A modified as per Rly Bd's letter no. 2002/Elect(G)/150/9/Pt dt 31.03.2009
3.	3 rd	27.09.10	-	-	Clause 10.0 and Annexure A deleted and clause 6.2.4 modified as per Railway Board's letter no. 2006/Elect(G)/150/9/Pt dated 10.09.2010
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जारीकर्ता
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27.05.2014

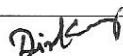
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SPECIFICATION FOR STAND-ALONE SOLAR PHOTOVOLTAIC LED BASED STREET LIGHTING SYSTEM

1.0 FORWARD

The Sun is an in-exhaustible, reliable and non-polluting source of power. Concerns over global climate change, local air pollution and resource scarcity make photovoltaic (PV) an increasingly attractive energy supply technology. The solar energy can be utilized for lighting purpose. This street light system is based on LED technology which consumes very low power and is a true energy saving solution.

2.0 SCOPE

This specification covers the general and technical requirements of LED based stand-alone solar photovoltaic street lighting system for uninterrupted illumination of the streets, pathways & surroundings of the buildings from dusk-to-dawn for security & safety.

3.0 REFERENCE STANDARDS

IS: 12834:1989 (reaffirmed 2000)	Solar Photovoltaic Energy Systems - Terminology
IEC: 61215 (2005)	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
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.

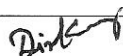
Note: Latest version of the standards shall be referred to.

4.0 SYSTEM DESCRIPTION:

Solar Photo Voltaic (SPV) based LED street lighting system shall consist of the following elements –

- SPV Module to convert solar radiation directly into electricity.
- 6 m high galvanized MS pole with necessary accessories.
- Battery bank to store the electrical energy generated by SPV panel during day time.
- Charge controller to maintain the battery to the highest possible State of Charge (SOC) while protecting the battery from deep discharge (by the loads) or extended overcharge (by the PV array).
- Blocking diode, preferably a Schottky diode, connected in series with solar cells and storage battery to keep the battery from discharging through the cell when there is no output or low output from the solar cell, if such diode is not provided with the module itself.

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- 15 W LED based luminaire as a light source.
- Interconnecting wires/cables & hardwares.

5.0 GENERAL REQUIREMENTS

- 5.1 The system has been designed to have 4 days autonomy (i.e. system is expected to run for 4 consecutive days without charging from the panel).
- 5.2. The street light pole shall be mounted clear of vegetation, trees & structure so as to assure that they are free of shadow throughout day light hours during each season of the year.
- 5.3. The entire system shall be designed and built to withstand the environmental conditions (mentioned in clause 6.2.6 or prevailing at site whichever is stiffer).
- 5.4. All wiring, enclosures and fixtures that are mounted outdoor must be resistant to high humidity conditions, corrosion, insect and dust intrusion.
- 5.5 Deleted
- 5.6 Deleted
- 5.7 Deleted
- 5.8 The system shall be virtually maintenance free (except for cleaning the top glass of the solar panel depending on dust conditions at place of installation)
- 5.9 All metal equipment cases and frames in the system shall be well grounded.
- 5.10 The main components shall be integrated in such a way as to allow replacement (in case of failure) with a similarly functioning component of a newer design or a different brand.
- 5.11 Electronic components used in charge controller or elsewhere in the system shall generally meet the requirements mentioned as follows (documentary evidence in support of the same should be given):
- (i) All capacitors shall be rated for max. temp of 105° C.
 - (ii) Resistances shall preferably be made of metal film of adequate rating having a tolerance of not more than 5%.
 - (iii) Switching devices such as transistors, IGBT MOSFETs etc shall have minimum junction temp. of 150° C.
 - (iv) Devices shall have adequate thermal margin at amb. temp. of 55° C
 - (v) Fibre glass epoxy of grade FR 4 or superior shall be used for PCB boards having a nominal board thickness 1.6mm and copper cladding thickness of 70 microns for power cards and 35 microns for control cards. Both track width and spacing between the tracks shall be 0.5 mm nominal and in no case shall be less than 0.3 mm. Assembled PCBs shall be given a conformal coating.

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6.0 TECHNICAL REQUIREMENT

Normal system voltage (rated voltage) shall be 12V dc.

6.1 System load

Load on the solar system shall comprise of the following:

- One 15W LED based luminaire mounted on the pole working for 12 hrs/day. (Dusk-to-Dawn)

The following factors have been considered during design stage of the solar system:

- Battery Autonomy – 4 days.
- Solar Insolation - 5 peak sun hours/day

6.2 SPV Module

6.2.1 Individual Solar PV Module should conform to IEC: 61215 Ed 2 or latest – Edition II, IEC : 61730 – I :2007, IEC : 61730 – II : 2007, manufactured in a plant certified under ISO 9001 : 2008 and also type tested by an accredited national/international testing laboratory. The Solar PV Module should be made from single/poly crystalline Silicon Solar Cell connected in series. 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 in the tender (refer item 1 in Annexure-D). Imported SPV module or cell will not be accepted, unless MNRE's policy/ rules permit the same.

6.2.2 SPV module shall contain crystalline silicon solar cells. The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.

6.2.3 A bird spike shall be provided to avoid bird sitting on the solar module at the highest point of the array/module structure.

6.2.4 SPV module shall be highly reliable, lightweight 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 not more than 20% at the end of 25 years.

6.2.5 Wherever more than one module is required, identical models shall be used.

6.2.6 The solar module shall be able to withstand the following environmental conditions normally encountered at site –

- temp. extremes ranging from -10°C to +85°C.
- Wind load – 200 km/h.
- maximum mean hourly rainfall of 40 mm.
- humidity level upto 95%.

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6.2.7 The conversion efficiency of Solar PV Cells used in the module shall not be less than 15% and that of the module shall be not less than 13%.

6.2.8 Marking:

Each module shall carry the following clear and indelible markings

- name, monogram or symbol of manufacturer;
- type or model number;
- serial number;
- polarity of terminals or leads (colour coding is permissible);
- Open – circuit voltage
- Operating voltage.
- maximum system voltage for which the module is suitable;
- Operating current
- Short circuit current
- Date & place of manufacture;.
- Weight of the module

6.2.9 Module shall be tested as per Annexure B.

6.2.10 The minimum module rating per LED based street light system shall be 80Wp.

6.2.11 Fill factor of the module shall not be less than 72%.

6.2.12 The solar module should have toughened high transmissivity glass in front side of the module for improved visibility and protection against environmental hazards (rain, hail and storm) and weather proof TEDLAR/POLYESTER back sheet.

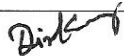

6.2.13 The transparency of toughened glass used shall be > 91%, when measured in actual sunlight by placing the glass plate perpendicular to the sun's rays through an air mass of 1.5. Certificate to this effect from a recognized test house or their own laboratory shall be submitted at the time of type approval.

6.2.14 The complete solar module shall be ensured for water-proof sealing in an anodized Aluminum frame.

6.2.15 The output terminals of the module shall be provided on the back of the solar PV module.

6.2.16 Terminal block shall be made of Noryl rubber or other suitable alternate materials with weatherproof design (minimum IP-65) and shall have a provision for opening for replacing the cables, if required.

6.2.17 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 its rating displayed.

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6.2.18 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 module as per ISO 9000 series.

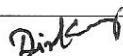
6.2.19 The SPV modules shall normally be mounted on a structure which is designed to withstand a wind speed of 200 kmph. For this compliance, contractor's certificate of conformity will be accepted.

6.2.20 The module junction boxes (if any) shall be certified as per IEC 61215. Else, they should have the same properties as mentioned for array junction boxes. If array junction boxes are used, they shall have the following properties:

- a) The module/array junction boxes shall be dust, vermin- and 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) Burning Behavior: Base part of Polycarbonate Enclosure shall be UL-94-V-0 compliant and Lid part of PC Enclosure shall be UL-94-V-2 compliant.
- e) The enclosures shall have IK 08 degree of protection for mechanical load.
- f) The material used shall be halogen, silicon free conforming to RoHS directive 2002/95/EC.
- g) The enclosure shall have a usage temperature rating of -10°C to 55°C .
- h) The enclosure should be chemically resistant to acid, lye, petrol, mineral oil and partially resistant to benzene.
- i) The material of the enclosure shall be UV stabilized.

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

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6.3 Battery Bank:

6.3.1 The storage battery Bank shall have enough capacity to keep the system going on without breakdown when the weather is not favorable for generation of electricity due to cloudy days and rains.

6.3.2 Unless otherwise specified by the purchaser, Battery Bank shall be Tubular Gel Valve Regulated Lead Acid Battery (VRLA) type complying IEC 60896 21 & 22. Gel tubular VRLA battery (when compared to the other type of VRLA battery) offers higher life in terms of cycles as well as years, there is far lower probability of PCL 3 effect, far lower risk of thermal runaway/ dry out failures and its capacity as well as internal resistance is relatively stable during lifetime. Flooded battery is not recommended as it requires topping up. The purchaser may at his option decide to specify any other type of battery, if considered necessary (refer item 2 of Annexure-D).

6.3.3 Deleted

6.3.4 T-gel type VRLA Battery shall have a design life expectancy of >5 years at 50% DOD at 27°C.

6.3.5 The permissible self-discharge rate for T-gel VRLA batteries shall be less than 2% of the rated capacity per month at 27°C.

6.3.6 The charging instructions shall be provided along with the batteries.

6.3.7 Deleted

6.3.8 The T-gel type VRLA batteries shall be discharged up to 80% DOD and battery shall be accordingly sized.

6.3.9 Suitable Battery Box made of Polycarbonate OR M.S fabricated with acid proof paint shall be provided to house the battery.

6.3.10 The minimum capacity of the battery bank shall be 12V/75 Ah @ C10

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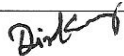

6.3.12 Make of the battery shall be finalized at the system design stage.

6.3.13 Battery Testing

Tubular Gel VRLA batteries shall have third party certifications for life test as per IEC 61427 for minimum requirement of 13 units @150cycles / unit equaling to 5 years life. All routine tests as per applicable standards shall be conducted on the batteries. Performance characteristics curves of the offered battery shall be submitted.

6.4 Charge Controller

6.4.1 Charge Controller shall be suitable for both LMLA as well as VRLA battery.

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- 6.4.2 Solar charge controller shall use PWM/ MPPT charging technology.
- 6.4.3 Battery will be allowed to discharge up to 80% DOD at the end of autonomy days. In such a situation charge controller shall automatically boost charge the battery.
- 6.4.4 On availability of sunshine (after autonomy days), the night load energy shall be delivered by the battery through the solar charge controller.
- 6.4.5 The controller shall have a “temperature compensation” feature.
- 6.4.6 Charge controller shall have automatic dusk-dawn circuit for switching on/off the street light without manual intervention.
- 6.4.7 The self consumption of the charge controller shall not be more than 10 mA at rated voltage and rated current.
- 6.4.8 It shall be capable of handling 120% of the module’s rated current for one hour duration.
- 6.4.9 The charge controller shall be compact in size, rugged, lightweight and easy to install in. ABS plastic enclosure
- 6.4.10 The Controller shall display the battery status as follows using 3 LEDs:
- | | | |
|------------|---|------------------------|
| Red LED | - | Low battery |
| Green LED | - | Battery on charge |
| Yellow LED | - | Battery fully charged. |

6.4.11 Solar Controller Testing

Tests in the following order shall be conducted:-

1. Functional Test – 100%
2. Insulation Resistance Measurement
3. Burn in test at 50 deg C Sample lot 6 hours 10% of ordered qty

6.5 LED Lamp & fixtures

Instead of designing/ manufacturing a luminaire especially for this application, a commercially available LED luminaire (or an improved version of it) of good repute/ performance record, if available, will be preferable. Unless otherwise specified in the following sub-clauses, LED/ luminaire manufacturer’s data-sheet/ conformance certificate will be accepted in lieu of tests.

- 6.5.1 Rated Power: 15 W (nominal)/ fixture. Power ratings are inclusive of driver losses.
- 6.5.2 Light intensity: 1200 system Lumens. Third party (NABL accredited lab) certificates for compliance can be accepted. Else, this is required to be demonstrated through a test.

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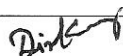
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- 6.5.3 LED type – White High Powered LED's 5500-6500 K temperature. Colour Binning should comply existing ANSI standard C78.377A. White Point Stability of LED should be within 7 McAdam Step. LED should be of SMD type only.
- 6.5.4 LED fixing arrangement - Mounted on metal core PCB fixed to aluminum heat sink.
- 6.5.5 Avg. illuminance delivered by outdoor luminaire shall be 4 lux at ground level (5m from the luminaire) and shall be measured using 9 point method as defined in Annexure-C. The ratio of minimum to average illumination shall be at least 0.4 and the transverse uniformity ratio i.e. minimum to maximum illumination shall be at least 0.33. Third party (NABL accredited lab) certificates for compliance shall be acceptable. Else, the same is required to be demonstrated through a test.
- 6.5.6 LED Fixture: Pressure die-cast LM6 housing with IP65 protection, having toughened glass/ UV stabilized polycarbonate cover.
- 6.5.7 LED used shall be of NICHIA / OSRAM / SEOUL SEMICONDUCTOR / PHILIPS LUMILEDS / LEDNIUM/ CREE make.
- 6.5.8 L 70 life of LED shall be 50,000 hours at soldering point temperature of 85 deg C and at luminaire operating current. The life time projection should be based on LM-80 test data and corresponding TM21 projection method for the corresponding driving currents at which the LEDs are driven.
- 6.5.9 Colour Rendering Index (CRI) shall not be less than 70 (nominal).
- 6.5.10 LED efficacy shall be minimum 100 lm @ 350mA drive current to meet the required LUX level. Nominal viewing angle of the LEDs used in the 15 W luminaire shall be 120°.
- 6.5.11 Junction to soldering point thermal resistance should be less than 10 degC/W for outdoor luminaires.
- 6.5.12 The 15W LED Luminaire for outdoor application shall be mounted on 5 m height from ground level on galvanized 6 m MS pole of nominal dia 3" with necessary accessories.
- 6.5.13 The LED luminaire shall comply IEC 60598/ IS 10322. Third party (NABL accredited lab) certificates for compliance shall be accepted. Else, this shall be demonstrated through a test.
- 6.5.14 The temperature of the heat sink shall not be greater than 20°C above ambient temperature even after 6 hours of continuous operation. Further, soldering point temperature of the LEDs used in the luminaire shall also be demonstrated through a test.
- 6.5.15 The LED driver DC current regulation shall be better than 3%.

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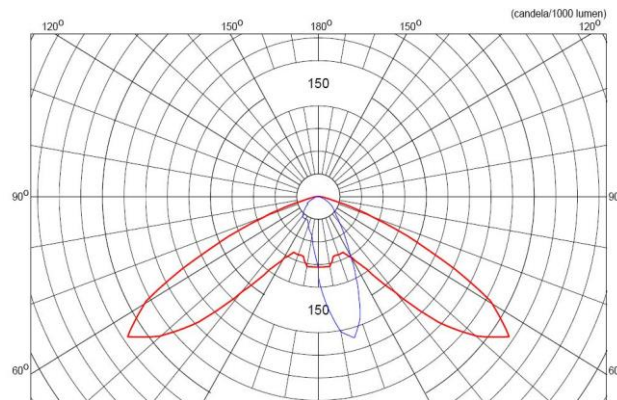


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6.5.16 The LED controlgear shall comply IS 15885 (Part 2 /Sec 13)/ IEC 61347-2-13 and IS 16104/ IEC 62384. Third party (NABL accredited lab) certificates for compliance shall be accepted. Else, this shall be demonstrated through a test.

6.5.17 Automatic dusk to dawn switching of the LED streetlights shall be integrated in the system.

6.5.18 Typical light distribution for outdoor luminaire should be as per the following polar curve:



6.5.19 For outdoor luminaires, LM 79 report is required to be submitted. Else, the same can be demonstrated through a test.

6.6 Cables and Hardware

6.6.1 Cabling of the system shall be as short as possible to minimize the voltage drop in the wiring

6.6.2 Cable shall meet IS 1554 / 694 Part 1:1988 & shall be of 650 V/ 1.1 kV

6.6.3 The modules and array wiring shall be water and UV resistant and suitable for Solar system application. The cables used shall be TUV 2Pfg 1169/08.2007 or VDE EPV 01:2008-02 or UL4703 certified.

6.6.4 All wiring must be sized to keep line voltage losses to less than 3% in each sub circuit and to allow the circuit to operate within the ampere rating of the wire.

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

6.7 Protections

6.7.1 Full protection against open circuit, accidental short-circuit & reverse polarity shall be provided.

6.7.2 Adequate protection shall also be incorporated under no-load conditions (i.e. when the system is ON & the load (LED Lamp is removed)).

6.7.3 If any other protection is necessary, the same will be deemed to be a part of the specification.

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6.8 The above technical requirements are given for general guidance only. The supplier/manufacturer shall submit the detail design of the complete solar lighting system considering the specific location, insolation, nature of load etc.

7.0 INSTALLATION & COMMISSIONING:

The installation shall be done by the supplier/manufacturer who is responsible for its performance and direction of installation & ensures 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.

8.0 DOCUMENTATION :

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

9.0 SPARE PARTS

One set of essential spares for the system being offered shall be included in the offer & details of the offered spares shall be included with the technical bid. The price for spares shall be quoted separately

10.0 GUARANTEE / WARRANTY

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11.0 DESIGN APPROVAL

Design for complete system, sub-system shall be approved by RDSO at design stage before manufacture of prototype conforming to this specification. The criteria for selection of sub-system / component shall be based on sound engineering practice conforming to the International / Indian Standards wherever specific standard is not specified in this specification. The detailed calculation/simulated results shall be submitted in support of system/sub-system rating. Adequate safety margin as stipulated in respective specification shall be used.

12.0 Tests

i) Type Tests

The prototype system shall be offered to RDSO for testing and approval. 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 comparable rating. However, the manufacturer cannot demand this as a matter of right.

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

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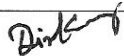

on the basis of firm's written clause-by-clause confirmation of the spec. and acceptance test alone, wherever this is considered necessary by CEE.

ii) Acceptance Tests

Acceptance testing shall be carried out by the purchaser or his representative or by any agency deputed by the purchaser on his behalf.

iii) Routine Tests

The manufacturer shall carry out routine tests at his works and shall maintain records for the same.

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Annexure-A**Eligibility criterion for bidding:**

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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:**

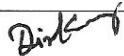

Each module shall be carefully inspected under an illumination of not less than 1,000 lux for the following conditions:

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

- i) Cell temp. of 25° C,
- ii) Incident solar irradiance of 1000W/m²,
- iii) Spectral distribution of light spectrum with an air mass AM=1.5

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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.

Test	Test Details	Actual test to be carried out at Govt. Recognized Lab or manufacturer premises as per standard
Cold Test	Temp. (-) 10 ⁰ C Duration: 16 hrs.	IEC-68-2-1
Dry Heat	Temp. (+) 70 ⁰ C Duration: 16 hrs	IEC-68-2-2
Salt spray*	Temp. (+) 35 ⁰ C, RH 95% Duration: 2 hrs spray and 22 hrs conditioning No. of Cycle : 01	IEC-68-2-11 Test Ka
Wind	Pressure equivalent to an air velocity of 200 km/hr.	
Rain	Test as required in the mentioned standards	JSS: 55555 (Test No. 12)
Dust	Temp : 40°C, RH < 50% Duration – 1 hr	JSS: 55555 (Test No. 14)
Others	Electrical Isolation test Routine test	Shall be done at manufacturers place for every modules offered

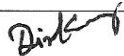

* If compliance to IEC 61701 has been asked by the purchaser, then this test will not be required.

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.

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.
- 5.5 Insulation Resistance not less than 50M-ohm at 500 V DC.
- 5.6 Degradation of performance may not exceed 5% after each single test or 8% after the whole sequence.

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Annexure - C**MEASUREMENT OF STREET LIGHTING LUX LEVELS**

9 point method –

Basics:

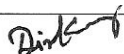

- Divide the section between two poles into 4 quadrants of equal size
- Measure the Lux levels at four corners of each quadrant
- Take the average of each quadrants
- Find the average of the all the four quadrants
- Distance between two poles shall be at 15 m and the width of the road is to be taken as the height of the pole i.e. 5 m.

Position	Pole 1	Mid-Point	Pole 2
Edge of the road near light	P1	P2	P3
Mid road	P4	P5	P6
opposite edge of the road	P7	P8	P9

$$\text{Average Lux levels} = (P1+P3+P9+P7)/16 + (P2+P6+P8+P4)/8 + (P5)/4$$

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

1. Is Salt Mist Corrosion Testing required (see Cl. 6.2.1) (Yes/No)
2. Battery type (see Cl. 6.3.2): _____

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