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**DRAFT SPECIFICATION
FOR
STAND-ALONE WIND + SOLAR PHOTOVOLTAIC HYBRID POWER
GENERATING SYSTEM FOR LEVEL CROSSING GATES**

S N	Amendment		Revision		Reason
	Number	Date	Number	Date.	
.1.	'1'	20.09.2010	-	-	Clause 6.2.14 deleted as duplicated Clause 9.0 (Guarantee/Warranty) and Annexure-3 (Eligibility Criteria for bidding) deleted as per Railway Board's letter No. 2006/Elect.(G)/150/9/Pt. dated 10.09.2010.
2.	2.	-	-	-	-

Approved by

Executive Director (EM)

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SPECIFICATION FOR STAND-ALONE WIND + SOLAR PHOTOVOLTAIC HYBRID POWER GENERATING SYSTEM FOR LEVEL CROSSING GATES

1.0 FOREWORD

The Wind and Sun are an in-exhaustive, reliable & non-polluting source of power. Concerns over global climate change, local air pollution & resource scarcity make Wind and photovoltaic (PV) an increasingly attractive energy supply technology. The Wind Solar Hybrid energy can be utilized for lighting purpose. Wind Solar Hybrid [WSH] generating system is ideal as power source in remote locations where the electricity is unavailable or erratic. Level Crossing Gate lighting system based on LED technology which consumes very low power, is a true replacement of normal energy intensive lightings.

2.0 SCOPE

This specification covers the general and technical requirements of Stand-alone Wind Solar Hybrid generating systems and LED based lights for uninterrupted illumination of the Level Crossing Gates. This system is recommended for installation at places where annual average wind speed is more that 3 m/s.

The released train light batteries may also be used as such the manufacture should consider the battery characteristic while designing the system. Following two options may be exercised by railways:

- i) WSHGS system with new battery
- ii) WSHGS system with released battery of TL system

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 specification shall be referred to.

4.0 SYSTEM DESCRIPTION:

Wind Solar Hybrid generating systems (WSHG) and LED based lights shall consists of the following elements -

- i) Wind Energy Generator [WEG] to convert Wind force to electricity.
- ii) 15 m height (minimum) galvanized MS tower with necessary accessories or as specified by the user..
- iii) SPV Module to convert solar radiation directly into electricity.
- iv) Module mounting structure of galvanized MS sections either on WEG tower or stand alone as per local conditions.
- v) Battery bank to store the electrical energy generated by WSH generating system.
- vi) The controller with following features:
 - a) The controller shall take backup power feeds from grid supply to charge the batteries when the battery energy storage falls below a particular threshold.
 - b) The controller shall give an Audio visual indication to start back-up generator when the battery storage falls below a particular threshold AND there is no Grid supply. An electrical control signal terminal shall be provided if the Generator has Auto start function.
 - c) The 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 WSHG system).
 - d) Blocking diode, preferably an 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 WSHG system, if such diode is not provided with the module itself.
- vii) LED based luminaries as a light source.
- viii) Interconnecting wires/cables & hardware.

5.0 GENERAL REQUIREMENTS

- 5.1 The system shall be designed to have 2 days autonomy (i.e. system will run for 2 consecutive days without charging from the panel).
- 5.2. The entire system shall be designed and built to withstand the environmental conditions (mentioned in clause 6.3.6 or prevailing at site whichever is stiffer).
- 5.3. All wiring, enclosures and fixtures that are mounted outdoor must be resistant to high humidity conditions, corrosion, insect and dust intrusion.
- 5.4. **Wind Energy Generator (WEG)** shall meet the following criteria

- 5.4.1. All exposed parts on WEG shall have multilayer Acrylic based painting system. Total thickness shall be 125 microns, the base metal shall undergo 7 tank process, green zinc followed by PU / Epoxy power coat, followed by a coat of epoxy / acrylic and final clear Acrylic coat.
- 5.4.2. Blades of Wind Generator shall be high performance Carbon fiber composite material only.
- 5.4.3. Stainless steel yaw shaft and bearing system base which is corrosion free and stronger than Medium Carbon Steel.
- 5.4.4. All fasteners in the WEG shall be Stainless steel 304.
- 5.4.5. All other fasteners shall be High Tensile.
- 5.4.6. All critical area welds checked with Die penetration test on sampling basis.
- 5.5 **The solar module** for the purpose of this specification shall consist of the following main components.
 - 5.5.1 An assembly of suitable inter-connected crystalline silicon solar cells.
 - 5.5.2 Toughened, high transmissivity glass in front side of the module for improved visibility & protection against environmental hazards, such as, rain, hail & storm and weather proof TEDLAR/POLYESTER back sheet.
 - 5.5.3 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. A certificate to this effect from the recognized test house or their own laboratory shall be submitted at the time of type approval.
 - 5.5.4 The complete solar module shall be ensured for water-proof sealing in an anodized aluminium frame.
 - 5.5.5 The output terminals of the module shall be provided on the back of the solar PV module.
 - 5.5.6 Terminal block shall be made of Nylon-6 or equivalent materials with weatherproof design (IP-65) and shall have a provision for opening for replacing the cables, if required.
 - 5.5.7 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)
- 5.6 **Battery Bank** shall be Tubular type / VRLA type or Released battery.
- 5.7 All metal equipment cases and frames in the system shall be well grounded.

- 5.8 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.
- 5.9 Electronic components used in controller or elsewhere in the system shall generally meet the requirements of IS:9000 and shall be as under: -
- (i) All capacitors shall be rated for max. temp of 105° C.
 - (ii) Resistances shall preferably be made of metal film of adequate rating.
 - (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.

6.0 TECHNICAL REQUIREMENT

Normal system voltage (rated voltage) shall be 12VDC.

6.1 System load

Load on the solar system shall comprise of the following:

- Two nos. 4W each LED based luminaries, one inside Goomti & one outside Goomti under shed working for 12 hours/day (Dusk to Dawn)
- One 18 W (maximum) DC fan inside Goomti working for 16 hours/day.
- Two 20W each LED based luminaries, one on each side of LC gate. These lights shall deliver minimum 15 LUX at 5 Meters.

The following factors shall be considered during design stage of the solar system:

- Battery autonomy – 2 days
- Operation period for indoor lighting – almost 20 hours.
- Operation period for outdoor lighting – almost 12 hours.
- Operation period for fan - almost 20 hours (in summer)
- Solar Insolation - 5 peak sun hours/day
- Wind speed at a minimum annual average of 3 meters/sec.

Total power requirement from the WSHG system shall be as given below:

Item	Watts	Qty	Hours of operation	Total WH per day
Cabin Lights	4	2	20	160
Cabin fan	18 max	1	20	360
Outdoor light	20	2	12	480
				1000

Generation from the WSHG system shall be expected as below:

Generation		Generation	Generation / day
Wind 650W	5 m/s avg wind speed	~90 KWH / month	~3000 WH
	3 m/s avg wind speed	~22 KWH / month	~750 WH
Solar 150W		~5 hrs /day	~750 WH

6.2 Wind Energy Generator (WEG)

6.2.1 Wind Energy Generators shall meet all the specifications listed in Annexure 1.

6.2.2 Alloy Copper Brush contacts on yaw bearing to ensure Nx360 deg yaw rotation for Wind generator. The Ring shall be of 90/10 Chromium Copper and the Contact Strips mounted on Beryllium Copper Strips. This is to ensure that there is no locking of cables or unwinding of cables.

6.2.3 High performance lifetime sealed dual track ball bearings for long lasting and smooth performance. The makes of the bearings shall be SKF/ Timken / Nippon.

6.2.4 Overwind protection shall be Electrodynamics Braking and Furling mechanism [Tilting WEG away from wind force]

6.2.5 Resin cast vacuum impregnated stator coils.

6.2.6 The alternator shall be made with class 'H' insulation.

6.2.7 All Stators shall be tested for: Dielectric, Insulation resistance / high voltage test as per IS 4722.

6.2.8 Alternator magnets shall be Ceramic magnets of Strontium Fe C10 grade.

6.2.9 Low loss thin Silicon Steel stamping of M45 to M63 grade.

6.2.10 High efficiency low COG loss permanent magnet radial flux alternator with minimum efficiency of 88%.

6.2.11 Suitable for low wind areas starting from 2.7 m/s [10.5 kmph] or lower.

6.2.12 Rated outputs to be taken at 10.5 m/s [37.8 kmph]

6.2.13 Towers for mounting shall be minimum 15 Meters height. However they shall be 5 meters above any obstruction in 200 meters radius. Towers have to be designed withstand a minimum wind force of 100 Kmph.

6.2.14 The WEG manufacturer shall certify that the WEG meets the power curve as per the particular model given in the Annexure 1.

6.2.15 The WEG manufacturer shall produce documentation that the Wind Generators meet the requirements as per para 5.4 and 6.2 above.

6.2.16 The supplier will furnish the characteristics of the WEG output while quoting for the tender.

6.3 SPV Modules

6.3.1 Only solar modules manufactured in accordance with the requirements of IEC: 61215 shall be offered.

6.3.2 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.

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

6.3.4 SPV module shall be highly reliable, light weight and shall have a service life of more than 20 years. SPV modules shall have a limited power loss of not more than 10% of nominal output at the end of 10 years.

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

6.3.6 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%.

6.3.7 The conversion efficiency of Solar PV Cells used in the module shall not be less than 15%.

6.3.8 The SPV Module shall be tested as per **Annexure 2**

6.4 Battery Bank:

6.4.1 The storage battery Bank shall have 2 nos. 120AH, 12V batteries.

6.4.2 Battery shall be Tubular Lead Acid, Low Maintenance type with low antimony lead alloy plates and ceramic vent plugs and water topping interval of 6 months which are specially designed to be charged & discharged frequently

and can handle heavy discharges time after time with minimum charging efficiency of 90%.

- 6.4.3 The container material shall be PP.
- 6.4.4 Battery shall have a design life expectancy of >5 years at 50% DOD at 27°C.
- 6.4.5 The permissible self-discharge rate shall be less than 2% of the rated capacity per month at 27°C.
- 6.4.6 The charging instructions shall be provided along with the batteries.
- 6.4.7 Batteries shall be provided with micro porous vent plugs & acid level indicator.
- 6.4.8 The batteries shall be discharged up to 80% DOD and battery shall be accordingly sized
- 6.4.9 Suitable Battery Box made of Plastic OR M.S fabricated shall be provided to house the battery.
- 6.4.10 Alternatively VRLA type battery of proven design for such application may also be considered provided such battery have been in such application for more than 3 years satisfactory service.
- 6.4.11 Type and make of the battery shall be approved at the system design stage.
- 6.4.12 Released batteries from railways may be used in place of above battery bank for which the prospective supplier of the WSHG system shall study these batteries and integrate with the system without affecting the over all performance of the system.

6.4.13 Battery Testing

All routine tests as per applicable standards shall be conducted on the batteries.

Performance characteristics curves as indicated below of the offered battery shall be submitted.

1. Charging-discharging characteristics at various temperature and cell voltage.
2. Self discharge at various ambient temperatures.
3. Cell voltage Vs. State of charge.
4. Capacity vs. Rate of discharge.
5. State of charge Vs. Sp. Gravity of electrolyte.
6. Depth of discharge Vs. No. of cycles.

6.5 Controller

- 6.5.1 The Controller shall be suitable for peak generation capacity of the Wind Solar Hybrid system and also be suitable for tubular/VRLA/ released battery.
- 6.5.2 Battery will be allowed to discharge up to 80% DOD at the end of autonomy days. In such a situation controller shall automatically boost charge the battery.
- 6.5.3 On availability of sun shine (after autonomy days), the night load energy shall be delivered by the battery through the controller.
- 6.5.4 The controller shall have a “temperature compensation” feature.
- 6.5.5 For LC Gates the controller shall have automatic dusk-dawn circuit for switching on/off the outdoor light without manual intervention.
- 6.5.6 The efficiency of the controller shall not be less than 98%.
- 6.5.7 It shall be capable of handling 120% of the module’s rated current for one hour duration.
- 6.5.8 The controller shall be compact in size, rugged in a metallic enclosure.
- 6.5.9 Safety Cutouts - Battery overcharge / wind generator over speeding / manual over ride stop switches, the controller shall continuously monitor Frequency / RPM / voltage of the wind generator and shall initiate protection signals whenever necessary,
- 6.5.10 Controller shall be designed for solar panels up to 350Wp and commensurate battery bank without any circuit changes for future expansion.
- 6.5.11 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.

6.5.13 Controller Testing

Tests in the following order shall be conducted:-

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

6.5.14 Dump Load

It shall be resistive type to dissipate extra power generated by the system and shall have following features:

- i) It shall be continuous rating of at least 800W.
- ii) Resistance material shall be Super Kanthal Stainless Steel (SS 304) elements with cooling fins, suitable for convection cooling and SS / Brass mounting hardware

6.6 LED Lamp & fixtures

- 6.6.1 Rated Power: 4 / 20 W fixture as required
- 6.6.2 Light intensity: 350/1500 Lumens (typical)
- 6.6.3 LED type – White High Powered LED's 5500-6500 K temperature (preferably surface mount power LED's)
- 6.6.4 LED fixing arrangement - Mounted on metal core PCB fixed to aluminum heat sink.
- 6.6.5 Illumination: For 20W lamp more than 15 Lux at 1 m from the ground (5 m from the Light source).
- 6.6.6 Indoor LED Fixture: ABS plastic/Aluminum fixture with acrylic cover with 120 degree viewing angle.
- 6.6.7 Outdoor LED Fixture: ABS plastic/Aluminum fixture with acrylic cover with IP 55 protection.
- 6.6.8 LED used shall be of NICHIA / OSRAM / SEOUL SEMICONDUCTOR / PHILLIPS LUMILEDS / LEDNIUM make.
- 6.6.9 L 70 life of LED shall be 50,000 hours at Junction temperature of 125°C

6.7 Fan

DC operated wall mounted bracket fan of 12V/15W rating shall be provided with lightweight plastic/polypropylene blades. With the following parameters;

- Air flow: More than 0.25 m³/sec.
- Fan sweep: 300 mm
- No. of blades :3
- Motor insulation: F Class
- Temp rise: less than 65° c. above ambient.
- Shroud shall be provided for protection.

6.8 Cables and Hardware

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

- 6.8.2 Cable shall meet IS 1554 / 694 Part 1:1988 & shall be of 650 V/ 1.1 kV
- 6.8.3 The modules and array wiring shall be water and UV resistant and suitable for Solar system application.
- 6.8.4 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.
- 6.8.5 Components and hardware shall be vandal and theft resistant. All parts shall be corrosion-resistant.

6.9 Protections

- 6.9.1 Full protection against open circuit, accidental short-circuit & reverse polarity shall be provided.
- 6.9.2 Adequate protection shall also be incorporated under no-load conditions (i.e. when the system is ON & there is no load)

6.10 Marking:

Each WSHG system shall carry the following clear and indelible markings on the controller:

- Name, monogram or symbol of system integrator;
- Type or model number;
- Serial number;
- Polarity of terminals or leads (colour coding is permissible);
- Output voltage.
- Max. Power output
- Date of supply
- SPV details:
 - Serial No.
 - Maximum system voltage for which the SPV module is suitable;
 - Open – circuit voltage
 - Operating current
 - Short circuit current
 - Date & place of manufacture.

- WEG details
 - Serial no.
 - Operating voltage
 - Wattage at rated wind speed.
 - Rated wind speed
 - Date of manufacture

- Battery type
 - Total AH
 - No./AH of batteries

7.0 INSTALLATION & COMMISSIONING:

The installation shall be done by the supplier/manufacture who is responsible for its performance and direction of installation. & ensures structural stability. The supplier shall conduct a detailed site assessment. The 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 shut down procedures.

9.0 GUARANTEE/WARRANTY (Deleted).

10.0 LOG BOOKS

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

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 PROTOTYPE APPROVAL

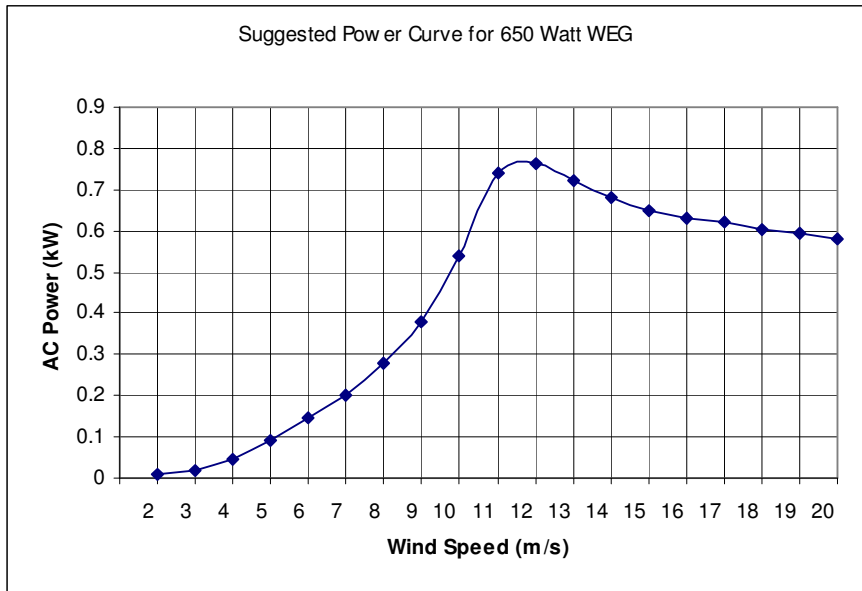
The prototype system shall be offered to RDSO/nominated agency by Indian Railways for testing and approval.

Annexure – 1

SPECIFICATIONS for WEG 650 Watts @ 10.5 m/s

ELECTRICAL GENERATOR	
DIAMETER, METERS (Minimum)	2.1
SWEPT AREA, SqM (Minimum)	3.4
NUMBER OF BLADES	3
BLADE MATERIAL	CARBON FIBRE REINFORCED
MINIMUM RATED POWER, WATTS@WIND SPEEDS 10.5 M/S	650
MINIMUM PEAK POWER @ 12.0 M/S or lower	750
CUT-IN WIND SPEED (Maximum)	2.7 M/Sec
STARTUP WIND SPEED (Maximum)	2.1 M/Sec
MECHANICAL MOUNTING	
MIN CLEARANCE BETWEEN BLADE AND TOWER BODY	20 CM
MOUNTING PIPE/TUBE	P 2.5" schedule 40 as per IS:1239
WEIGHT OF WEG (MAXIMUM)	25 Kg.
LATERAL THRUST	550 NEWTONS

POWER CURVE	
Wind speed m/s	Power KW (Minimum)
2	0.009
3	0.016
4	0.046
5	0.090
6	0.144
7	0.202
8	0.280
9	0.378
10	0.540
11	0.740
12	0.765
13	0.722
14	0.680
15	0.649
16	0.632
17	0.621
18	0.605
19	0.594
20	0.580



Annexure - 2

Quality Testing of PV-Module

Solar PV module shall be certified according to IEC 61215. The qualification testing procedure is defined in IEC 61215 to examine the impact of mechanical, thermal & electrical stress on power output. Bidder shall submit appropriate type approval certificate for the offered solar modules from IEC approved laboratories.

Method of Testing

1.0 Visual Inspection:

Each module shall be carefully inspected under an illumination of not less than 1000 lux for the following conditions:

- cracked, bent, misaligned or torn external surfaces.
- broken / cracked cells
- faulty interconnections or joints;
- cells touching one another or the frame;
- failure of adhesive bonds; bubbles or delaminations forming a continuous path
- between a cell & edge of the module;
- faulty terminations, exposed live electrical parts
- Junction box should have common terminals with suitable bypass diode for preventing hot spot problem..

2.0 Performance at STC: (Clause 10.1 of IEC 61215:2005)

The current-voltage characteristics of the module shall be determined in accordance with IEC 60904-1 at a specific set of irradiance & temp conditions

Performance of PV-Module shall be generally evaluated at Standard-Test-Conditions (STC) as defined in IEC 60904 standards:

- cell temp of 25° C,
- incident solar irradiance of 1000W/m²,
- spectral distribution of light spectrum with an air mass AM=1.5

3.0 ENVIRONMENTAL TESTING

Following environmental test shall be conducted on offered module for initial clearance of the offered system once in 2 years.

Test	Test Details	Actual test to be carried out at Govt. Recognized Lab or manufacturer premises as per standard
Cold Test	Temp. (-) 40 ⁰ C Duration: 16 hrs.	IEC-68-2-1
Rapid change of temp.	Low Temp. : (-) 40 ⁰ C High Temp. :(+) 85 ⁰ C No. of Cycles : 10 Duration Exposure: 30 min Rise / Fall of temp : 1 ⁰ C / Minute	IEC-68-2-14
Dry Heat	Temp. (+) 85 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 ⁰ C, RH < 50% Duration – 1 hr	JSS: 55555 (Test No. 14)
Composite Temp and humidity Test	Temp between 25 ⁰ C, 65 ⁰ C and -10 ⁰ C, RH: 95% Dwell time : At 65 ⁰ C with 95% RH : 05+05 Hrs At 25 ⁰ C with 95% RH: 30+30 min. At 10 ⁰ C : 2 hrs Rise & Fall time : 2 ½ + 2 ½ + 1 ½ Hrs, Duration – 240 hrs. No. of Cycles – 10	IEC –68-2-38
Others	Electrical Isolation test Routine test	Shall be done at manufacturers place for every modules offered

4.0 Acceptance Criteria:

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

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