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Ministry of Energy, Water Resources and Irrigation
Alternative Energy Promotion Centre

NEPAL PHOTOVOLTAIC QUALITY ASSURANCE-2025 (NEPQA-2025)

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Preamble

This technical standard for components of a Solar Photovoltaic (PV) System, called Nepal Photovoltaic Quality Assurance (NEPQA), was first developed and adopted by the Alternative Energy Promotion Centre/ Energy Sector Assistance Programme (AEPC/ESAP) in December 2000 for dissemination of Solar Home Systems (SHS) under ESAP and termed as Nepal Interim Photovoltaic Quality Assurance (NIPQA). The interim standard was needed due to the absence of Nepal Standard (NS) for the components used in PV systems. It was revised for the first time in November 2002, the second time in September 2005, the third time in July 2009 and it has been renamed then after Photovoltaic Quality Assurance (NEPQA) as Nepal, the fourth time in 2013, fifth time in 2015 and this is the sixth revision and has been coined as Nepal Photovoltaic Quality Assurance-2025 (NEPQA-2025).

NEPQA specifies the documents and technical requirements of the components used in PV applications i. e. Solar Home System (SHS) [>10 Wp to 1000 Wp], Small Solar Home System (SSHS) [≤10 Wp] and Institutional PV applications, Institutional pumping PV system etc. Based on this document, the Renewable Energy Test Station (RETS) will test and certify the quality of the PV systems and components used in PV applications. This document is fully owned by AEPC, RETS and the entire PV sector.

RETS shall conduct two types of tests: Product Introduction Test (PIT) and Random Sampling Test (RST). RETS prepares, updates the *Test Procedures and Sampling Plan* based on its existing resources and capacity. The sampling sizes and testing procedures are defined in the document *Test Procedures and Sampling Plan of RETS*.

Adoption of best available and Innovative technologies will be encouraged and promoted.

The Renewable Energy Test Station (RETS) is authorized to carry out the quality test of the Solar Photovoltaic system and its components and issue the certificate using the *Sampling Plan and Test Procedures of RETS*.

Relevant definitions are provided in the end of the document.

VALIDITY OF DOCUMENT

This document is an amendment of existing NEPQA 2015.rev1 and amendment is made in required provision replaces the NEPQA 2015.rev1 as whole and will be effective from its approval date and shall remain valid until a new version formally replaces it.

List of Abbreviations

AEPC	Alternative Energy Promotion Centre
AGM	Absorbed Glass Material
BMS	Battery Management System
CC	Charge Controller
CBTL	Certification Body Testing Laboratory
CCT	Correlated Color Temperature
CRI	Color Rendering Index
DC	Direct Current
DoD	Depth of Discharge
FF	Fill Factor
IEC	International Electrotechnical Commission
IECEE	IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components
IECRE	IEC System for Certification to Standards relating to Equipment for use in Renewable Energy Applications
IP	Ingress Protection
ISPS	Institutional Solar PV System
ISO	International Organization for Standardization
HVD	High Voltage Disconnect
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LVD	Low Voltage Disconnect
LVR	Low Voltage Reconnect
MCPCB	Metal Core Printed Circuit Board
MPPT	Maximum Power Point Tracker
NCB	National Certification Body
NEPQA	Nepal Photovoltaic Quality Assurance
NS	Nepal Standard

PCB	Printed Circuit Board
PIT	Product Introduction Test
PV	Photovoltaic
PVPS	Photovoltaic Pumping System
PWM	Pulse Width Modulation
RECB	Renewable Energy Certification Body
RETL	Renewable Energy Testing Laboratory
RETS	Renewable Energy Test Station
RFID	Radio Frequency Identification
RST	Random Sampling Test
SC	Short circuit
SHS	Solar Home System
SMPS	Switched Mode Power Supply
SPV	Solar Photovoltaic
SSHS	Small Solar Home System
STC	Standard Test Condition
THD	Total Harmonic Distortion
UV	Ultraviolet
VA	Volt-Ampere
VAC	AC Voltage
VDC	DC Voltage
VRLA	Valve Regulated Lead Acid Battery
WLED	White Light Emitting Diode

List of Definitions

1. A "Solar Home System" (hereinafter called SHS) is a photovoltaic system of more than 10Wp up to 1000Wp used for domestic and commercial purposes for providing primarily lighting services. Additional services such as information and entertainment through television sets or radios as well as fans may also be provided.
2. A “Small Solar Home System" (hereinafter called SSHS) is a 10Wp photovoltaic system used for domestic purposes for providing basic lighting services and access to information through a small radio. It consists of WLED DC lamps, radios as well as outlet for mobile charging. The system can have separate charge controller and battery or can have an integrated charge controller and battery.
3. An “Institutional Solar PV System” (hereafter called ISPS) is a DC or AC photovoltaic system used for lighting and power supply to appliances like computer, telephone, refrigerator, etc., in public institutions like VDC buildings, schools, health posts, religious buildings, clubs, etc.
4. A “Photovoltaic Pumping System” (hereafter called PVPS) is a DC or AC photovoltaic water pumping system operated by photovoltaic electricity to lift water for drinking and drip irrigation purposes.
5. Absorbed Glass Mat (AGM) battery: A technique for sealed lead-acid batteries. The electrolyte is absorbed in a matrix of glass fibers, which holds the electrolyte next to the plate, and immobilizes it preventing spills.
6. Ambient Temperature: The temperature of the surrounding area.
7. Ampere-Hour (Ah): A measure of the flow of current (in amperes) over one hour; used to measure and specify the capacity of the battery.
8. Autonomy Days (N): Maximum number of consecutive days where the daily load can be fulfilled without charging the battery, starting the first day with a fully charged battery.
9. Battery: Two or more electrochemical cells enclosed in a container and electrically interconnected in an appropriate series/parallel arrangement to provide the required operating voltage and current levels.
10. Battery Capacity: The maximum total electrical charge, expressed in ampere-hours, which a battery can deliver to a load under a specific set of conditions.
11. Battery Cycle Life: The number of cycles, to a specified depth of discharge, that a battery can undergo before failing to meet its specified capacity or efficiency performance criteria.
12. Battery Cycle: The discharge and subsequent charge of a battery.
13. Ballast: An electronic device that converts DC to AC and regulates and controls the current through a fluorescent tubular lamp.
14. Bypass Diode: A diode connected across one or more solar cells in a photovoltaic module such that the diode will conduct if the cell(s) become reverse biased. It protects these solar such that the diode will conduct if the cell(s) become reverse biased. It protects these solar cells from thermal destruction in case of total or partial

shading of individual solar cells while other cells are exposed to full light.

15. C-Rate: C-Rate refers to charge (or discharge) rate of a battery. The number indicates the number of hours to completely charge or discharge the battery at a constant current. C20 is the current draw at which the battery will last for 20 hours, C10 is the current at which the battery will last for 10 hour. The useful capacity of a battery changes depending on the discharge rate, so battery capacities are stated with respect to a particular rate.

16. Charge Controller: A component of a photovoltaic system that controls the flow of current to and from the battery to protect it from over-charge and over-discharge.

17. Color Rendering Index (CRI): The calculated rendered color of an object. The higher the CRI (based upon a 0-100 scale), the more natural the colors appear. Natural outdoor light has a CRI of 100.

18. Deep-Cycle Battery: A battery that can withstand many discharges to a low state-of-charge.

19. Depth of Discharge (DOD): The ampere-hours delivered from a fully charged battery, expressed as a percentage of rated capacity. For example, the delivered of 20 ampere-hours from a fully charged 100 ampere-hours rated cell results in a 20% depth of discharge.

20. Flooded Lead-Acid Battery: A battery containing a liquid solution of sulphuric acid and water.

21. Gel-Type Battery: Lead-acid battery in which the electrolyte is composed of a silica gel matrix.

22. High Voltage Disconnect: The voltage at which a charge controller will disconnect the photovoltaic module from the battery to prevent overcharging.

23. Hybrid Inverter: Inverters have a built-in charge controller functionality.

24. Innovation: An innovation refers to a product type not yet included in the current NEPQA version. The designation and function of the product type must be different from the existing ones or at least include additional features in usage to the end-user.

25. Lead-Acid Battery: A general category that includes batteries with plates made of pure lead, lead-antimony, or lead-calcium immersed in an acid electrolyte.

26. Low Voltage Disconnect (LVD): The voltage level at which a charge controller will disconnect the load from the battery.

27. Lumen (lm): The SI unit of luminous flux or quantity of light and equals the amount of light that is spread over a square foot of surface by one candle power when all parts of the surface are exactly one foot from the light source.

28. Lumens per watt (lm/W): The amount of light a light source produces for each watt of electricity consumed.

29. Lux (lx): The SI unit of illuminance, or luminous flux incident on a unit area, frequently defined as one lumen per square meter (lm/sq.m).

30. Open-Circuit Voltage (Voc): The maximum possible voltage across a photovoltaic Module at no load condition.

31. Maximum Power Current (Imp): The current at which maximum power is available from a PV module.

32. Maximum Power Voltage (Vmp): The voltage at which maximum power is available from a PV module.

33. Non- Subsidy Scheme: In this category, the components and systems for non-subsidy scheme shall be tested and certified. Any importer or manufacturer willing to test and certify the products from RETS falls in this category.

34. Peak Watt: A unit used to rate the performance of solar module. Maximum nominal output of a photovoltaic device, in watts (Wp) under STC.

35. Photovoltaic (PV) System: A complete set of components for converting sunlight into electricity by the photovoltaic process, including the array and balance of system

36. Pulse Width Modulation (PWM): A battery charging algorithm to achieve constant voltage battery charging by switching the controller's power device. In PMW regulation, the current from the solar array tapers according to the battery's condition and recharging need.

37. Rated Battery Capacity: The term used by battery manufacturers to indicate the maximum amount of energy that can be withdrawn from a battery under specified discharge rate and temperature.

38. Reverse Leakage Current Protection: Protection in charge controller for preventing unwanted current flow from the battery to the PV module (usually at night).

39. Sealed Battery: A battery with a captive electrolyte and a resealing vent cap, also called a valve-regulated battery. Electrolyte cannot be added.

40. Self-Discharge: The rate at which a battery, without load, will discharge.

41. Short-Circuit Current (Isc): The current flowing freely through an external circuit that has no load or resistance; the maximum current possible.

42. Solar Home System: A "Solar Home System" (hereinafter called SHS) is a photovoltaic system used for providing primarily lighting services.

43. Specific Gravity: The ratio of the weight of the solution to the weight of an equal volume of water at a specified temperature.

44. Standard Test Conditions (STC): Standard Test Condition is defined as 1,000 W/m^2 solar radiations in the plane of the array, 1.5 air-mass ratios and 25^0C cell temperature.

45. State-of-Charge (SOC): The available capacity remaining in the battery, expressed as a percentage of the rated capacity.

46. Subsidy Scheme: The components and systems to be installed under government subsidy scheme through AEPC as per the guidelines of subsidy delivery mechanism shall be tested and certified under this category.

47. Third party: Testing and Certification Institution duly accredited by the authorized entity of the government.

48. Voltage at Maximum Power (Vmp): The voltage at which maximum power is available from a photovoltaic module.

49. Solar Inverter: Solar inverter converts the variable direct current (DC), having single or multiple input supplies, into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network.

Content

1 Specifications for Core Components of Solar Photovoltaic System 1
1.1 PV Module 1
1.1.1 General Requirements 1
1.1.2 Required Documents 1
1.1.3 Technical Requirements 2
1.2 Battery 3
1.2.1 General Requirements 3
1.2.2 Required Documents 3
1.2.3 Technical Requirements 4
1.3 Charge Controller 5
1.3.1 General Requirements 5
1.3.2 Required Documents 5
1.3.3 Technical Requirements 6
1.4 PV Inverter or Grid Connected Inverter 8
1.4.1 General Requirements 8
1.4.2 Required Documents 8
1.4.3 Technical Requirements 8
1.5 Battery Inverter 10
1.5.1 General Requirements 10
1.5.2 Required Documents 10
1.5.3 Technical Requirements 10
1.6 Lamps 12
1.6.1 General Requirements 12
1.6.2 Required Documents 12
1.6.3 Technical Requirements 12
1.7 Pump 13
1.7.1 General Requirements 13
1.7.2 Required Documents 13
1.7.3 Technical Requirements 14
1.8 Street Light 15
1.8.1 General Requirements 15
1.8.2 Required Documents 15
1.8.3 Technical Requirements 15
2 Testing of Integrated Solar PV System Products 17
3 RETS Testing Procedure 17
4 Procedures for Innovations Entering the Market 17

1 Specifications for Core Components of Solar Photovoltaic System

1.1 PV Module

1.1.1 General Requirements

The PV module must be of Crystalline Silicon or Thin film Type.

1.1.2 Required Documents

i. The PV module test certificates from IEC accredited laboratory must be provided according to:

a) The PV modules must have and IEC 61215-2:2021: Terrestrial photovoltaic (PV) modules - Design qualification and type approval – Part 1: Test requirements and Part 2: Test procedures

b) The PV modules must have IEC61730-1:2016, IEC 61730-2:2016 - Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction and Part 2: Requirements for testing

c) The PV modules must have IEC 61215-1-2:2021 - Terrestrial Photovoltaic (PV) Modules - Design qualification and type approval – Part 1-2: Special requirements for testing of thin film based photovoltaic (PV) modules

d) The PV modules must have IEC62804-1:2015- Photovoltaic (PV) Modules – Test methods for the detection of potential induced degradation - Part 1: Crystalline silicon (For PV Module above 350Wp) IEC 61215-1:2021

e) The PV modules must have IEC 61701:2020 – Photovoltaic (PV) Modules – Salt mist corrosion testing (For PV module above 350Wp)

f) The PV modules must have IEC 62716:2013 – Photovoltaic (PV) Modules - Ammonia corrosion testing (For PV module above 350Wp)

The PV Module must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website. The enlisted CBTL or RETL or NCB or RECB must have Scope of PV Module Testing for IEC 61215, IEC 61730.

ii. A letter provided by principal PV Module manufacturer in their letter head stating the warranty period for their PV module.

iii. Catalogue and technical datasheet of PV Module.

1.1.3 Technical Requirements

i. The Crystalline PV module must have positive power tolerance within 0 to +20% up to 100Wp, 0 to +10% greater than 100Wp to 200Wp and 0 to +3% above 200Wp and within 0 to +5% for Thin Film type.

ii. The maximum power voltage (Vmp) of the PV modules to be used for 12V systems must be at least 17.5 V at STC.

iii. The module efficiency for crystalline module must be at least 14% up to 150Wp, at least 18% for above 150Wp to 350Wp and at least 21% for above 350Wp. The module efficiency for thin film module must be at least 14%.

iv. Crystalline PV modules must have inbuilt bypass diodes. The junction box must have at least IP65 protection according to IEC 60529.

v. For Crystalline Module up to 150Wp, the Fill Factor (FF) must be at least 70%. For Crystalline Module above 150Wp and Thin Film Module, the Fill Factor must be at least 75%.

vi. The PV connector type supplied by the module manufacturer or approved by the module manufacturer must be used and must comply with IEC 62852. Degree of protection at least IP67 according to IEC 60529.

vii. The serial number must be laminated inside the glass of the PV Module.

viii. The warranty of the module must be as follows.

For Crystalline Module up to 150Wp,
The Product Warranty must be minimum 5 years
The Power Output Warranty must be:
10 years: ≥ 90% of STC Power
25 years: ≥ 80% of STC Power

For Crystalline Module above 150Wp and Thin Film Module,
The Product Warranty must be minimum 10 years
The Power Output Warranty must be:
first year: ≥ 97% of STC power
10 years: ≥ 90% of STC Power
25 years: ≥ 80% of STC Power
and linear warranty ≤ 0.8% per year from year 2 and onwards

ix. The PV module must be provided with nameplate label consisting of indelible markings at the back of module. The nameplate must contain the following information.

a) Nominal Power in Wp

b) Name of the manufacturer

c) Brand, Model and Type

d) Voltage at maximum power

e) Current at maximum power

f) Open circuit voltage

g) Short circuit current

h) Maximum System Voltage

1.2 Battery

1.2.1 General Requirements

The battery must be a deep cycle type and of following category.

i. Lead Acid Battery: Flooded Tubular or Vented Tubular

ii. Valve Regulated Lead Acid Battery: Tubular

iii. Lithium Ion (Li-Ion)

Note: AEPC will promote new innovations and technology in batteries. Such batteries shall be tested as per the manufacturer's claim and test procedures.

1.2.2 Required Documents

i. The Battery test certificates/reports from IEC accredited laboratory must be provided according to:

a) IEC 61427-1:2013 - Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1: Photovoltaic off-grid applications.

However, for 2V VRLA Gel Tubular Batteries, the following standards shall apply:

IEC 60896-21:2004 – Stationary lead-acid batteries – Part 21: Valve-regulated types – Testing methods.

IEC 60896-22:2004 – Stationary lead-acid batteries – Part 22: Valve-regulated types – Requirements.

b) IEC 61427-2:2015- Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: Photovoltaic on-grid applications

c) IEC 60896-11:2002 - Stationary lead-acid batteries - Part 11: Vented types - General requirements and methods of tests for 2V Flooded Tubular Battery

d) IEC 62619:2022 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications (including battery pack)

The Battery must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website.

In case of domestic products the manufacturer must provide a declaration of equivalency with the above-mentioned test certificate/ test reports.

ii. In case of local battery manufacturer, document stating warranty period and after sales services has to be provided in their letter head signed and stamped by authorized person.

iii. Catalogue and technical datasheet of Battery.

1.2.3 Technical Requirements

i. The life cycle of battery must be of at least

   a) 1,200 cycles at 80% DoD for 12V Flooded Lead Acid battery and 12V VRLA Lead Acid Battery

   b) 1,500 cycles at 80% DoD for 2V Flooded and 2V VRLA Gel Lead Acid battery

   c) 800 cycles at 80% DoD for 2V VRLA AGM Lead Acid battery

   d) 3,000 cycles at 80% DoD for Lithium-Ion battery. For battery packs with capacities below 2 kWh, 2,000 cycles at 80% DoD shall be accepted.

ii. The battery must have positive capacity tolerance of 0 to +20% within 5 cycles of test.

iii. Battery C-Rate must be at least

   a) 0.1C for Lead Acid Battery

   b) 0.2C for Lithium Ion Battery.

iv. The serial number must be engraved/screen printed on the outer surface of the battery for Lead Acid Battery.

v. For Lithium-Ion batteries, a Battery Management System (BMS) must be included by the battery manufacturer to ensure safety protection (voltage, current and temperature control at cell level). Safety protection against thermal runaway, over charging and over discharging shall be ensured by the battery manufacturer.

vi. A flooded type battery must have electrolyte level indicator.

vii. The round-trip efficiency must be at least 85%.

viii. The warranty of the battery must be of at least:

   a) 3 years for 12V Flooded Lead Acid Battery and 12V VRLA Lead Acid Battery

   b) 5 years for 2V Flooded and 2V VRLA Gel Tubular Lead Acid Battery

   c) 3 years for 2V VRLA AGM Lead Acid Battery

   d) 5 years for Lithium Ion-Battery with BMS

ix. For lead acid battery, the following minimum information must be included on the label of the battery and the label must be printed on the battery. The label must contain the following information.

   a) Name of the manufacturer

b) Brand, Model and Type

c) Rated capacity in Ampere-hours at the discharge rate

d) Nominal voltage

x. For Lithium Ion, the following information must be included on the label of the battery and the label must be printed on the battery. The label must contain the following information:

a) Name of the manufacturer

b) Brand, Model and Type

c) Rated capacity

d) Nominal voltage

e) Serial number

1.3 Charge Controller

1.3.1 General Requirements

The Charge Controller must be of following category.

i. PWM Charge Controller: 12V/24V/48V for capacity < 20A

ii. MPPT Charge Controller

1.3.2 Required Documents

i. The Charge Controller must be manufactured in compliance with the provision 1.3.3 and must be declared by the manufacturer for the capacity ≤ 3kW

ii. For the Charge Controller capacity > 3kW, the controller test certificate from IEC accredited laboratory must be provided according to IEC 62109-1:2010 - Safety of power converters for use in photovoltaic power systems - Part 1: General requirements. The Charge Controller must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website. The enlisted CBTL or RETL or NCB or RECB must have Scope of Charge Controller Testing. In case of in-built charge controller, inverter certification shall be valid.

iii. In case of local charge controller manufacturer, it has to provide document stating warranty period for their charge controller in their letter head signed and stamped by authorized person.

iv. Catalogue and technical datasheet of Charge Controller.

1.3.3 Technical Requirements

i. The Charge Controller must have deep discharge protection and must be compatible to the battery type used. For Lithium Ion, deep discharge protection shall be managed by BMS.

ii. Low Voltage Disconnection (LVD) for lead acid batteries must not be less than 11.4V for 12V system and 11.4X, V for 12X, V system voltage. Where X is a natural number with the same value. For 6V system, the LVD must not be less than 5.7V. Setting point must be within +/- 2% at 25°C.

iii. Low Voltage Reconnection (LVR) must not be less than 12.5V for 12V system and 12.5X, V for 12X, V system voltage. Where X is a natural number with the same value. For 6V system the LVR must not be less than 6.25V. Setting point must be within +/- 2% at 25°C. Charge controller designed for Lithium Ion, LVR is not applicable.

iv. High Voltage Disconnection (HVD) must be within the range of (14V-15V)X, Volt for 12X, Voltage system. HVD should be below 15X, V for flooded lead acid batteries and below (14- 14.1)X, V for VRLA Gel and AGM batteries. For 6V, VLRA batteries, the HVD must be within the range of (7.0 – 7.05)V. For Lithium Ion battery, HVD must be at 4.2X, V for X number of 3.7 V cells Lithium Cobalt Oxide ($LiCoO_2$) in series and 3.6X, V for X number of 3.2V cells Lithium Ferrous Phosphate($LiFePO_4$) in series. Setting point must be within +/-2% of Manufacturer's claim at 25°C. Other than above mentioned voltage system for Lithium Ion, the HVD must be in the range of 13% to 21%higher than nominal voltage. Where X is a natural number with the same value.

v. Usage of electro-mechanical relays is not permitted.

vi. The charge controller to be used in street lights must have at least 3 stages of dimming functionality.

vii. The Charge Controller must include

   a) Protection against reverse polarity must be provided in both the PV module and battery sides.

   b) Short circuit protection on load side must be provided.

   c) Over current protection on the load side and surge protection on module side must be provided.

viii. The allowable Printed Circuit Board (PCB) for solar charge controllers is

   a) Glass epoxy

   b) Metal core printed circuit board (MCPCB)

ix. The charge controller enclosure must have at least IP20 protection according to IEC 60529.

x. Charge controller up to 10A capacity must have an inbuilt connected switched mode power supply (SMPS) based mobile charging point with an efficiency of at least 80%.

xi. The efficiency of the PWM charge controller must be at least 90% and MPPT charge controller must be at least 95%.

xii. For PWM based controllers, the quiescent current consumption must not exceed

   a) 20mA at nominal voltage (the non-critical indicators are turned off) for charge controller sized up to 20A.

b) 25mA at nominal voltage (LCD Display) for charge controller sized up to 20A.

xiii. For MPPT based controllers, the quiescent current consumption must not exceed

a) 25mA at nominal voltage (the non-critical indicators are turned off) for charge controller sized up to 20A.

b) 35mA at nominal voltage (LCD Display) for charge controller sized up to 20 A.

c) 40mA at nominal voltage for CC (LED indicators) above 20A and up to 60A and 60mA at nominal system voltage for CC (LCD display) above 20A and up to 60A.

d) 100mA at nominal voltage for CC above 60A.

xiv. For MPPT charge controller having no load terminal, only charging side parameters will be tested.

xv. The warranty of the charge controller must be of at least:

a) 3 years for controllers with capacities up to 60A

b) 5 years for controllers with capacities above 60A

xvi. For PWM charge controller, the following information must be included on the label of the controller. The label must contain the following information:

a) Name of the Manufacturer

b) Brand, Model and Type

c) Rated capacity

d) Nominal voltage

e) Serial Number

f) Input current

g) Load current (not applicable for charge controller having no load terminal)

xvii. For MPPT charge controller, the following information must be included on the label of the controller. The label must contain the following information:

a) Name of the Manufacturer

b) Brand, Model and Type

c) Rated capacity

d) Voltage range

e) Serial Number

f) Maximum wattage

1.4 PV Inverter or Grid Connected Inverter

1.4.1 General Requirements

The PV inverter or Grid connected inverter should match voltage, frequency, phase angle and phase sequences of National Grid or Mini Grid System. The PV inverter shall also in house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter. The MPPT quality standard should match with the requirements applicable to Section 1.3.3.

The inverter generated total harmonic distortion (THD), flicker, DC injection limits, Voltage Range, Frequency Range, Power Factor Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest Grid Code of Nepal Electricity Authority.

1.4.2 Required Documents

i. The PV Inverter test certificates from IEC accredited laboratory must be provided according to:

   a) IEC 61727:2004 - Photovoltaic (PV) Systems: Characteristics of Utility Interface

   b) IEC 62116:2014 - Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures

   c) IEC 62891:2020: Maximum power point tracking efficiency of grid-connected photovoltaic inverters

   d) IEC 62109-1:2010 & IEC 62109-2:2011 - Safety of power converters for use in photovoltaic power systems - Part 1: General requirements and Part 2: Particular requirements for inverters

   The Inverter must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website. The enlisted CBTL or RETL or NCB or RECB must have Scope of PV Inverter Testing.

ii. A local importer must provide a document of agreement between the local importer and the principal inverter manufacturer, signed and stamped by authorized persons stating the warranty period for their PV inverter.

iii. Catalogue and technical datasheet of PV Inverter.

1.4.3 Technical Requirements

i. The Inverter must have a rated AC output voltage of

   a) Three Phase 400±10% VAC (L-L),

   b) Single Phase 230±10% VAC (L-N)

ii. The output frequency of the inverter must be 50Hz ± 2.5%.

iii. The efficiency of MPPT input must be at least 95%.

iv. The efficiency of inverter must be at least 95% for up to 5kVA inverters and at least 97% for above 5kVA inverters for transformer less topology.

v. The euro efficiency of inverter must be at least 94% for up to 5kVA inverters and at least 96% for above 5kVA inverters for transformer less topology. The efficiency curve of efficiency Vs power output must be provided.

vi. The efficiency of inverter must be at least 90% for transformer topology.

vii. The no load loss must be less than 0.5% of rated power for transformer less topology.

viii. The no load loss must be less than 1.5% of rated power for transformer topology.

ix. The total harmonic distortion (THD) must be less than 5% at full load.

x. The inverter must maintain the power factor greater than 0.99 (>0.99) at nominal power and adjustable range between 0.8 leading to 0.8 lagging.

xi. The inverter must have at least IP65 protection according to IEC 60529.

xii. The inverter must have to built-in meter and data logger to monitor system performance through external user interface.

xiii. The inverter must have internal protection against DC reverse polarity, sustained or momentary fault in National Grid/Mini Grid and against the lightning on feeder.

xiv. The inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

xv. The inverter must have either cooling system with fan or appropriate heat sink to avoid excessive heating.

xvi. The warranty of the PV inverter must be at least 5 years.

xvii. The following minimum information must be included on the label of the inverter. The label must contain the following information.

a) Name of the manufacturer

b) Brand, Model and Type

c) Rated Power in Watt or VA

d) Input and output voltage in Volt and Frequency in Hz

e) Maximum Input Voltage

f) MPPT Voltage Range

g) Serial Number

1.5 Battery Inverter

1.5.1 General Requirements

The Battery Inverter must be compatible with Lead Acid Battery or Lithium Ion Battery or any other battery types recommended by the manufacturer. The inverter must be of following type.

i. Stand-alone or Off-grid Inverter (DC-AC Inverter)

ii. Hybrid Inverter

iii. Bidirectional Inverter

1.5.2 Required Documents

i. The Stand-alone Inverter must be manufactured in compliance with the provision 1.5.3 and the statement must be declared by the manufacturer.

ii. The Hybrid Inverter must be manufactured in compliance with the provision 1.5.3 and the statement must be declared by the manufacturer.

iii. The Bidirectional Inverter must be manufactured in compliance with the provision 1.5.3 and the statement must be declared by the manufacturer for inverter capacity up to 3kVA.

iv. For the bidirectional inverter capacity above 5kVA, the inverter test certificate from IEC accredited laboratory must be provided according to IEC 62109-1:2010 - Safety of power converters for use in photovoltaic power systems - Part 1: General requirements.

The Bidirectional Inverter must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website. The enlisted CBTL or RETL or NCB or RECB must have Scope of Battery Inverter Testing.

v. A local importer must provide a document of agreement between the local importer and the principal inverter manufacturer, signed and stamped by authorized persons stating the warranty period for their battery inverter. In case of local inverter manufacturer, it has to provide document stating warranty period for their battery inverter in their letter head signed and stamped by authorized person.

vi. Catalogue and technical datasheet of Battery Inverter.

1.5.3 Technical Requirements

i. The Inverter must have a rated AC output voltage of

a) Three Phase 400±10% VAC (L-L),

b) Single Phase 230 ±10% VAC (L-N)

ii. The Output frequency of the inverter must be 50Hz ± 2.5%.

iii. The efficiency of inverter must be at least 85% at full load at nominal voltage with transformer topology and must be at least 90% at full load at nominal voltage with transformer less topology.

iv. The efficiency when operating loads at power levels between 40% to 90% of the rated load must be greater than 90% for transformer less topology.

v. The efficiency when operating loads at power levels between 40% to 90% of the rated load must be greater than 80% for transformer topology.

vi. The no load loss must be less than 1% of rated power for transformer less topology.

vii. The no load loss must be less than 2% of rated power with transformer topology.

viii. The total harmonic distortion (THD) must be less than 5% at full load.

ix. The inverter must maintain the power factor between 0.8 Lagging to 0.8 Leading.

x. The inverter must have at least IP21 protection according to IEC 60529.

xi. The inverter must not produce noise more than 60db at 2meter distance.

xii. Hybrid Inverter must have solar charging priority.

xiii. Inverter or Inverter circuits must include

a) Low battery shut down must be at battery voltage not less than 10.5V for lead acid battery in case of 12V systems. For 24V or 48V systems low battery shut down voltage must be 10.5 x N, V. Here N stands for the number of 12 V batteries in a series connection.

b) Reverse polarity protection on DC input terminals.

c) Short Circuit protection of the output terminals.

d) Appropriate indicators main, charging, inverter ON, short circuit and overload.

xviii. The inverter must have either cooling system with fan or appropriate heat sink to avoid excessive heating.

xix. Inverter must be capable of operating safely for at least 2 seconds at 150% of rated power.

xx. For Inverter with inbuilt charge controller, the charging side of charge controller will be tested as per provision stated in charge controller section and load side parameters of charge controller will not be tested.

xxi. The warranty for the battery inverter must be at least:

a) 3 years for capacity up to 5kVA

b) 5 years for capacity above 5kVA

xxii. The following minimum information must be included on the label of the inverter. The label must contain the following information.

a) Name of the manufacturer

b) Brand and Model

c) Rated Power in Watt or VA

d) Input and output voltage in Volt and Frequency in Hz

e) Serial Number

1.6 Lamps

1.6.1 General Requirements

The Lamp must be Light Emitting Diode (LED) Lamp and must be DC or AC type.

1.6.2 Required Documents

i. A letter provided by principal lamp manufacturer in their letter head mentioning the operational life of the lamp to be at least 30,000 hours.

ii. A local importer must provide a document of agreement between the local importer and the principal lamp manufacturer, signed and stamped by authorized persons stating the warranty period for their lamp. In case of local lamp manufacturer, it has to provide document stating warranty period for their lamp in their letter head signed and stamped by authorized person.

iii. A local manufacturer or local importer must provide a LED Manufacturer test reports as per LM 80 (IES Approved Method for Measuring Lumen Maintenance of LED Light Sources) from IEC accredited laboratory.

iv. Catalogue and technical datasheet of Lamp and Individual LED

1.6.3 Technical Requirements

i. The rated power of Lamp must have power tolerance of +/-10%.

ii. A viewing angle of individual LED must be equal to or greater than 2*60 degree.

iii. The Luminous Efficacy of individual LED must be at least 130 Lumen/Watt for Cool Light and at least 110 Lumen/Watt for Warm Light.

iv. The lamp driver circuit efficiency with constant power driver must be at least 85%.

v. The Color Rendering Index (CRI) of the individual LED must be at least 80 for Day/Cool Light and at least 70 for Warm Light.

vi. The correlated color temperature (CCT) must be:

a) Warm Light: 2500K to 4000K

b) Day/Cool Light: >4000K to 6500K

vii. The LED bulb must have diffuser with anti-glare properties other than warm light.

viii. Luminous efficacy or Luminous yield of lamp must not differ by more than 5% from the initial value after burning for 200 continuous hours under constant current source.

ix. The Luminous Efficacy of Lamp must be

a) Warm Light: at least 85 Lumen/watt.

b) Cool Light: at least 100 Lumen/Watt.

x. The power factor for AC Lamp must be at least 0.9 Lagging.

xi. The lamp enclosure must have at least IP20 protection according to IEC 60529.

xii. The lamp must be protected against reverse polarity for DC Lamp.

xiii. A heat-sink must be of metal or of equivalent materials and connected using a suitable heat-transfer material.

xiv. The surface temperature of the LEDs lamp must remain below 50ºC during operation.

xv. The warranty of the Lamp must be of at least 3 years.

xvi. The AC Lamp must have good working capability for voltage range from 190V to 270V.

xvii. The total harmonic distortion (THD) of AC Lamp must be less than 5%.

xviii. The following minimum information must be included on the label of the lamp and the label must be printed on the lamp. The label must contain the following information.

a) Brand

b) Nominal power in Watt

c) Nominal voltage

d) Color Temperature

e) Serial Number

1.7 Pump and Pump Controller

1.7.1 General Requirements

The Pump must be Submersible or Surface and of following category.

i. DC Pump

ii. AC Pump

1.7.2 Required Documents

i. One of the products of the Pump Manufacturer must have at least one of the following Certificates of Conformity, issued by an IEC-accredited laboratory, provided in accordance with:

IEC 62253:2011 - Photovoltaic pumping systems - Design qualification and performance measurements.

IEC 61000-6-1:2016- Electromagnetic compatibility (EMC) - Part 6-1: Generic

standards - Immunity standard for residential, commercial, and light-industrial environments.

IEC 62109-3:2020-Safety of power converters for use in photovoltaic power systems - Part 3: Particular requirements for electronic devices in combination with photovoltaic elements

IEC 60335-1:2020- Household and similar electrical appliances - Safety - Part 1: General requirements

The Solar Pump must be certified by Certification Body Testing Laboratory (CBTL) or Renewable Energy Testing Laboratory (RETL) or National Certification Body (NCB) or Renewable Energy Certification Body (RECB) enlisted in the IECEE website or IECRE website.

A local importer must provide a document of agreement between the local importer and the principal pump manufacturer, signed and stamped by authorized person stating the warranty period for their pump.

ii. Catalogue and technical datasheet of Pump and Pump Controller.

1.7.3 Technical Requirements

i. The pump motor combined efficiency must be at least 50%. The pump performance curve (flow vs. power at rated head) must be provided.

ii. The motor shall be brushes or brushless DC motor.

iii. The pump set must have Maximum Power Point Tracker (MPPT) to optimally use the solar power and maximize the water discharge.

iv. The efficiency of MPPT must be at least 95%.

v. The pump set (Pump and Motor) must have at least IP68 protection for Submersible Pump and at least IP65 protection for Surface Pump according to IEC 60529.

vi. The pump controller and switch box must have at least IP65 protection according to IEC 60529.

vii. The pump controller or pump set must include protection against:

a) Dry run

b) Insufficient power

c) Reverse polarity

d) Short circuit

e) Over temperature

f) Surge

viii. The pump must be manufactured with non-corrosive materials. Ceramic or equivalent non corrodible materials must be used for bearings. Pump body, rotors and impellers must be made of stainless steel with a minimum grade of AISI 304 or

higher.

xix. The warranty must be at least:

a) 3 years for Pump Set

b) 3 years for Pump Controller

xx. The following minimum information must be included on the label of the pump and the label must be printed on the pump. The label must contain the minimum following information.

a) Name of the manufacturer

b) Brand, Model and Type

c) Rated Flow

d) Rated Head

e) Serial Number

f) Nominal Power

1.8 Street Light

1.8.1 General Requirements

The Lamp must be Light Emitting Diode (LED) Lamp and must be DC or AC type.

1.8.2 Required Documents

i. A letter provided by principal lamp manufacturer in their letter head mentioning the operational life of the lamp to be at least 50,000 hours.

ii. A local importer must provide a document of agreement between the local importer and the principal street light manufacturer, signed and stamped by authorized persons stating the warranty period for their street light. In case of local light manufacturer, it has to provide document stating warranty period for their street light in their letter head signed and stamped by authorized person.

iii. A local manufacturer or local importer must provide a LED Manufacturer test reports as per LM80 (IES Approved Method for Measuring Lumen Maintenance of LED Light Sources) from IEC accredited laboratory.

iv. Catalogue and technical datasheet of Street Lamp and Individual LED.

1.8.3 Technical Requirements

i. The rated power of Street Light must have power tolerance of +/- 5%.

ii. A viewing angle of individual LED must be at least 2*60 degree.

iii. The Luminous Efficacy of individual WLED must be at least 140 Lumen/Watt.

iv. The luminance must be at least 0.5 Lux/Watt at the ground at the height of 9 meters.

v. The lamp driver circuit efficiency with constant power driver must be at least 90% with three stage control mode.

vi. The Color Rendering Index (CRI) of the individual LED must be at least 80 for Cool Light and at least 70 for Warm Light.

vii. The color temperature must be:

a) Warm Light: 2500K to 4000K

b) Day/Cool Light: >4000K to 6500K

viii. The Luminous Yield of Lamp must be

a) Warm Light: at least 100 Lumen/watt

b) Day/Cool Light: at least 120 Lumen/watt

ix. The power factor for AC Street Lamp must be at least 0.9 Lagging.

x. The light enclosure must have at least IP66 protection according to IEC 60529.

xi. The Street Light must be protected against reverse polarity for DC type.

xii. A heat-sink must be of metal or of equivalent materials and connected using a suitable heat-transfer material.

xiii. The surface temperature of the light must remain below 50ºC during operation.

xiv. The warranty of the Street Light must be of at least 5 years.

xv. The total harmonic distortion (THD) of AC Street Light must be less than 5%.

xvi. The AC Street Light must have day/night sensor and surge protection device.

xvii. The AC Street Light must have good working capability for voltage range from 190V to 270V.

xxi. The following minimum information must be included on the label of the light. The label must contain the following information.

a) Name of the manufacturer

b) Brand, Model and Type

c) Nominal power in Watt

d) Nominal voltage

e) Color Temperature

f) Lumen Output

g) Serial Number

2 Testing of Integrated Solar PV System Products

Integrated products that compromise a set of solar PV components housed in a single unit shall be tested as one product, following specifications of the integrated components.

3 RETS Testing Procedure

The Renewable Energy Test Station (RETS) is authorized to carry out the quality test of the Solar Photovoltaic system and its components and issue the certificate.

4 Procedures for Innovations Entering the Market

For new and innovative products of Solar PV system (see definition “innovation”), the manufacturer or importer shall provide third party quality certificate issued from accredited national or international laboratory. The manufacturer or the importer must provide the detailed contact of the manufacturer and the certifying laboratory, so that RETS can contact and request for suitable testing procedures cross-checking them with international standards.

RETS will upgrade the test facilities and develop procedures in order to test and verify the specification claimed by the manufacturer and observe its operation and issue the observation Certificate.

Annex 1. Additional restrictions for Subsidized PV system components

a) Thin Film solar modules are not acceptable in SSHS.

b) For SSHS, the battery can be rechargeable Nickel Metal Hydride (Ni-MH) or Lithium Ion (Li-Ion).

Minimum Required Standard of PV System Components (Less than 10Wp)

1.1 PV Module

1.1.1 Required Documents

1. A letter provided by PV manufacturer in their letter head stating the warranty period of the PV Module. The warranty period of Solar PV Module must be at least 10 years against maximum 10% reduction in output power at STC.
2. The larger size PV module/s manufactured by the company must have IEC Certification.
3. Catalogue and technical specification of the PV modules

1.1.2 Technical Requirement

1. The PV module must be of Crystalline Silicon. The rated output power and the maximum rated voltage of the module need to be tested and certified by Renewable Energy Test Station (RETS) to confirm the following requirements:
    - Deviation of maximum power from nominal values stated by the manufacturer must be within – 5% and +20% (minus five and plus twenty) at STC.
    - The maximum rated voltage (Vmp) of the PV modules to be used for 12V systems must be at least 17 V at STC. For system less than 12V, the Vmp of the module must be 33% higher than the system voltage at STC.
2. A nameplate must be mounted on the PV module frame with the following details:
    - Name of the manufacturer
    - Model or Type No.
    - Maximum power in Watt Peak
    - Maximum rated voltage in Volt
    - Maximum rated current in Ampere

1.2. Battery

1.2.1 Required Documents

1. A letter provided by principle battery manufacturers in their letter head mentioning the warranty for at least 2 years
2. Catalogue and technical specification of the battery.

1.2.2 Technical Requirements

1. The battery must be rechargeable Nickel Metal Hydride (Ni-MH) or Lithium Ion (Li-Ion).
2. The operational life cycle of Li-Ion and Ni-MH batteries must be 1000 cycles.
3. The capacity of battery should be less than 10Ah. The Panel battery (Wp:WH) (Watt peak to Watt Hour) ratio should be maintained 1: (7.2-9.6).
4. The deviation of battery capacity from its rated capacity stated by the manufacturer must not exceed the limit of -5% to +20% (minus 5% to plus 20%) within 5 cycles of test.
5. The following minimum information must be included in the label of the battery:

- Rated capacity in Ampere-hours
- Nominal voltage in Volt

1.3 Charge Controller

1.3.1 Required Documents

1. A letter provided by principle manufacturers in their letter head mentioning the warranty for at least 2 years

1.3.2 Technical Requirements

1. The Charge controller must have the following settings:

   A. HVD must be at 4.2xN V for N number of 3.7 V cells for Li-Ion (LiCoO2) or Ni-MH cells in series.
   B. HVD must be at 3.6xN V for N number of 3.2-3.3 V (LiFePO4) cells in series.
   C. For other system voltages, HVD must be in the range of 13% to 21% higher than the system voltage.
   D. Setting point must be within +/- (plus minus) 2% of manufacturer claim at 25^0C.

1.4 Lamp

1.4.1 Required Documents

2. Lamp test certificate issued by third party or

   A statement provided by WLED lamp manufacturer in their letter head describing the quality assurance that the lamps meet the technical requirements as defined in the 1.4.2

3. A letter provided by principle manufacturers in their letter head mentioning the warranty for at least 2 years

1.4.2 Technical Requirements

1. The Lamp must be of White LED(s).
2. A viewing angle of individual WLED must be equal to or greater than 2*50 degree.
3. The luminous Efficacy(lm/w) of individual WLED must be at least 100 Lumen/Watt
4. WLED driver circuit efficiency must be at least 80%.
5. Luminous Efficacy (Lm/W) of WLED lamp must not differ by more than 5 % after 200 hours of continuous burning from its original value.
6. The Color Rendering Index (CRI) of the WLED must not be less than 60 and the color temperature must be in the range of 5000°K to 6000°K.
7. The lamp and its enclosure should display good workmanship and should provide protection against dust, oil, and smoke.

1.5 Test Detail:

For this capacity of solar system, RETS will test with the following procedures:

- Design Verification

- Quality testing of complete solar package and individual PV components.

1.6 Integrated SPV Products or System having inseparable components of the whole PV system (Less than 5Wp only)

1. Document Requirement
   - The importer/manufacturers must submit third party Quality Product Certificate of the solar package or its components, issued from the national or international laboratory.
   - A letter provided by principle manufacturers in their letter head mentioning the warranty for at least 2 years
2. Design Consideration:
   - Li-Ion and Ni-MH batteries must have minimum 1000 cycles.
   - Insolation: 5000Wh/m2/day and autonomy day: 1
3. Preliminary test :
4. It includes visual screening to assess the workmanship of the mounting, fixtures, connection and cabling, PCB soldier joints, switches circuit, mechanical and electronics layout of the Solar Package and housing of the components.
5. Design Verification by RETS in perspective of energy balance using standard practices
6. RETS will perform testing of technical parameter of SPV system components which is possible with RETS facility[PV Module capacity deviation: +20/-5%], Battery capacity [above claimed and -5% to+20%], Luminous Yield of lamps/LED[above claimed and -5%]
7. The Lux output of lamp from 2m height must not be less than 8 Lux. (At bright mode)
8. RETS will perform real time test against manufacturer/importer claim working hours and product must comply rated performance within 5 (five) cycles.