Government of Nepal
Ministry of Population and Environment

Alternative Energy Promotion Centre

Nepal Photovoltaic Quality Assurance (NEPQA) 2015.rev1

February 2016

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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 and fifth time in 2015 and this is the sixth revision and has been coined as Nepal Photovoltaic Quality Assurance (NEPQA) -2015.rev 1.

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.

VALITDITY OF DOCUMENT

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

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List of Abbreviations

AEPC	Alternative Energy Promotion Centre
AGM	Absorbed Glass Material
CC	Charge Controller
CBTL	Certifying Body Testing Laboratory
CCT	Correlated Color Temperature
CFL	Compact Fluorescent Lamp
CRI	Color Rendering Index
DC	Direct Current
DoD	Depth of Discharge
ESAP	Energy Sector Assistance Programme
IEC	International Electro technical Commission
ISPS	Institutional Solar PV System
ISO	International Organization for Standardization
HVD	High voltage disconnect
LED	Light-Emitting Diode
Li-Ion	Lithium-Ion Battery
LPW	Lumen per Watt
LVD	Low-Voltage Disconnect
LVR	Low-Voltage Reconnect
MC	Management Committee
MCPCB	Metal Core Printed Circuit Board
MPPT	Maximum Power Point Tracker
NCB	National Certifying Body
NEPQA	Nepal Photovoltaic Quality Assurance
NiMH	Nickel-Metal Hydride Battery
NS	Nepal Standard
PIT	Product Introduction Test
PV	Photovoltaic

PVPS	Photovoltaic Pumping System
PWM	Pulse-Width Modulation
RETS	Renewable Energy Test Station
RST	Random Sampling Test
SC	Short circuit
SHS	Solar Home System
SMPS	Switched-Mode Power Supply
SPV	Solar Photovoltaic
sqm	square meters
SSHS	Small Solar Home System
STC	Standard Test Condition
THD	Total Harmonic Distortion
UV	Ultra-violet
V	Voltmeter
VA	Volt-Ampere
VDC	DC Voltage
VRLA	Valve-Regulated Lead Acid Battery
WLED	White Light Emitting Diode

List of Symbols

C10	10-hour rate of the battery
C20	20-hour rate of the battery
C5	5-hour rate of the battery
I	Current
I_m	Maximum Current
I_{mp}	Current value of máximum power point
I_{SC}	Short-circuit current
L	Length of wire
Lm	Lumen
Lx	Lux
N	Autonomy days
P_{in}	Input Power
P_m	Maximum Power Point
V	Voltage
V_{mp}	Voltage value of maximum power point
V_{oc}	Open-circuit voltage
Wp	Watt Peak
η	Efficiency

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 (Mono Crystalline or Poly Crystalline) or Thin film Type.

1.1.2 Required Documents

IEC certificate of PV module. Model/type of PV module must be mentioned in certificate.

i. The PV Module must be certified by a Certifying Body Testing Laboratory (CBTL) or National Certifying Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have scope of PV Testing.

a) Mono Crystalline Silicon PV module and Poly Crystalline Silicon PV module must be tested and certified according to the standard-"IEC 61215 Edition 2 2005-04 (or EN 61215 Edition 2) - Crystalline Silicon Terrestrial Photovoltaic (PV) - Design Qualification and Type Approval".

b) Thin-film PV modules must be tested and certified according to the standard - "IEC 61646 - Thin-film Terrestrial Photovoltaic (PV) Modules- Design Qualification and Type Approval".

ii. A letter provided by principal PV module manufacturer in their letter head stating the warranty period for their PV module. The warranty period for the PV Module must be at least 10 years against a maximum 10% reduction and 20 years against a maximum 20% reduction of output power at STC.

iii. A local importer must provide a document of agreement between the local importer and the principle PV manufacturer, signed and stamped by authorized persons stating warranty period and after sales services for their PV Module. In case of local PV manufacturer, it has to provide document stating warranty period stated in clause (ii) above and after sales services for their module in their letter head signed and stamped by authorized person.

iv. Catalogue and technical specification of PV module.

1.1.3 Technical Requirements

i. The following electrical parameters of the module will be tested and certified by Renewable Energy Test Station (RETS).

a) Deviation of maximum power from nominal values stated by the manufacturer must be within – 5% and +20% (minus five and plus twenty) at STC. In case of Thin-film type modules, deviation of maximum power will be measured after

exposing the PV modules in ambient conditions for two consecutive periods of exposure of at least 43 kWh/ m2 according to IEC 61646 10.19.

b) The maximum power voltage (Vmp) of the PV modules to be used for 12V systems must be at least 17 V at STC. And for 12X, V system voltage Vmp must be at least 17X, V at STC, where X is a natural number. For systems different from 12X V, the Vmp of the module at STC must be at least 40% higher than the system voltage.

ii. Crystalline PV modules of 40Wp or above must have inbuilt bypass diodes. The module will be configured such that strings of maximally 20 cells are bridged by a bypass diode. The Junction box needs not be opened, if the principal PV manufacturer provides an assurance using their letter head about the existence of bypass diodes in the junction box.

iii. The module efficiency for crystalline module must be at least 10 % for upto 10 Wp, 11% for above 10 Wp to 50 Wp, 12% for above 50 Wp to 100 Wp, and 14% for above 100 Wp.

iv. The module efficiency for thin film module must be at least 8% up to 100 Wp and 10% above 100Wp.

v. The PV module must carry the following indelible markings

- Name of the manufacturer
- Model or Type No.
- Maximum rated voltage and current
- Open Circuit Voltage and Short circuit current
- Serial Number of PV Module

For Crystalline Modules, additionally

- Nominal power in Wp

For thin film modules, additionally

- Nominal and minimum values of maximum output power at STC (i.e. lowest stabilized power), as specified by the manufacturer for the product type.

vi. Serial Number, model name and brand name must be laminated inside the glass for crystalline modules of capacity up to 100 Watt peak. For panels above 100 Watt peak mentioning of only serial number laminated inside the glass will suffice.

vii. Readable mentioning of serial number, model name/number and brand name is a must for thin film modules. This mentioning can be at the front of the panel or at the back by laser marking on the substrate or engraving on bus-bars.

1.2 Battery

1.2.1 General requirements

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

i. Flooded lead acid battery Vented; Tubular plate

ii. Valve Regulated Lead acid battery (Gel and other types of electrolyte); Tubular plate

iii. Nickel Metal Hydride (Ni-MH)

iv. Lithium Ion (Li-Ion)

1.2.2 Required Documents

i. Battery test certificate according to PV_Gap-PVRS5A, IEC 60896 or IEC61427 or DIN 40744 issued by third party or a statement provided by principal battery manufacturer in their letter head describing the quality assurance and testing method used by them to assure that the battery meets the technical requirements stated in the corresponding chapters of this document.

ii. Catalogue and technical specification of battery.

iii. Battery capacity rating must be provided for 10 hour discharge time (C10).

iv. The local importer must provide a document of agreement between the local importer and the principle battery manufacturer, signed and stamped by authorized persons stating the warranty period specified in the technical requirements of the corresponding chapter in this document and after sales services for their battery. Local battery manufactures must provide a document stating the warranty period specified in the technical requirements of the corresponding chapter in this document and after sales services for their battery in their letter head signed and stamped by an authorized person.

1.2.3 Technical Requirements

All life cycle specifications are given for 25°C.

i. The operation cycle life of Li-Ion/Ni-MH battery must be at least 3,000 cycles at 20% DoD and 1,500 cycles at 80% DoD.

ii. The operational cycle life of lead acid battery must be at least 3,000 cycles at 20% DoD and 1,500 cycles at 70% DoD, whereby the EoL is determined as 80% of rated capacity remaining.

iii. For the batteries with capacity greater than 10 Ah, deviation of battery capacity from its rated value must not exceed + 20% (plus twenty) and -5 %(minus five) within 10 cycles of the test. And for the batteries with capacity less or equal to 10 Ah, the deviation of battery capacity from its rated value stated by the manufacturer must not exceed the limit of -5% to +20% (minus 5% to plus 20%) within 5 cycles of test. This clause applies for all above mentioned battery types.

iv. The charge/discharge efficiency of the battery must not be less than 80% for flooded type, 90% for VRLA, 70% for NiMH, 90% for Li-Ion.

v. The manufacturer's serial number must be engraved on the outer surface of the battery.

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

vii. 1. The following minimum information must be included on the label of the battery and the label must be screen printed on the battery casing for lead acid batteries.

c) Battery Manufacturer

d) Model/Brand and type

e) Rated capacity in Ampere-hours at the discharge rate C10

f) Nominal voltage

2. For Li-Ion, $LiCO_2$, $LiFePO_4$, Ni-MH batteries, the following information must be included on the label of the battery and the label must be indelible or printed on the surface of battery. The label must contain the following information:
   a) Battery manufacturer
   b) Model/Brand and type
   c) Rated Capacity
   d) Nominal Voltage
   e) Serial number. (In a system, the system serial number can be considered as the battery serial number.)

viii. The warranty of the battery must be of at least 3 years.

1.3 Charge Controller

1.3.1 Required Documents

i. Charge Controller test certificate issued by third party OR a statement provided by principal charge controller manufacturer in their letter head describing the quality assurance and testing method used by them to assure that the charge controller meets the technical requirements stated in this chapter.

ii. Catalogue and technical specification of charge controller

iii. Local importer must provide a document of agreement between local importer and principle Charge Controller manufacturer, signed and stamped by authorized persons stating warranty period of at least 3 years and after sales services for their Charge Controller. In case of local charge controller manufacturer, it has to provide document stating warranty period of at least 3 years and after sales services for their charge controller in their letter head signed and stamped by authorized person.

1.3.2 Technical Requirements

i. The charge controller must function in accordance with Pulse Width Modulation (PWM) or Maximum Power Point Tracking (MPPT) principles.

ii. Must have deep discharge protection with any options for manual deactivation that is adaptable to the battery type used, applicable to advanced type like Microcontroller based CC.

Charge controller designed for Li-Ion and Ni-MH type batteries, deep discharge protection is not mandatory. (Charge Controller designed for batteries like Li-Ion, $LiCoO_2$ $LiFePO_4$, Ni-MH must have printed information about using battery type.)

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

Charge controller designed for Li-Ion, Ni-MH type batteries, LVD is not applicable.

iv. 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. For a 6 V system the LVR must not be less than 6.25 V. Setting point must be within +/- 2% at 25°C.

Charge controller designed for Li-Ion, Ni-MH type batteries, LVR is not applicable.

v. The charge controller must have an over charge protection. High Voltage Disconnection (HVD) must be within the range of (14 -15)X, V for 12X, V system. HVD should be below 15X, V for flooded lead acid batteries and below 14.5X, V for gel and AGM batteries. For a 6 V, VLRA batteries, the HVD must be within the range of 7.0 – 7.25 V. For Li-Ion HVD must be at 4.2X, V for X number of 3.7 V cells ($LiCoO_2$) in series and 3.6X, V for X number of 3.2-3.3 V cells ($LiFePO_4$) in series. For NiMH, a HVD is not applicable, balancing of charging current or similar methods must assure, that the charging energy remains below 1.4 times the discharging capacity. Setting point must be within +/- (plus and minus) 2% of Manufacturer's claim at 25°C.

For batteries like Li-Ion, $LiCoO_2$ $LiFePO_4$, NiMH, with other than system voltage mentioned above, the HVD must be in the range of 13% to 21% (thirteen percent to Twenty one percent) higher than system voltage

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

vii. The charge controller must withstand the rated current from the PV module to battery and from battery to load at an ambient temperature range of –5°C to 40°C.

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

ix. Short circuit protection must be included on load.

x. Over-current on load side and surge protection on module side must be provided.

xi. The allowable Printed Circuit Board (PCB) for solar charge controller is

- Glass epoxy
- Metal core printed circuit board (MCPCB)

xii. Charge controller boxes should display good workmanship and should have protection against direct entry of dust, moisture, oil, and smoke etc.

xiii. Charge controller up to 10 A capacity must have either an inbuilt or externally connected switched mode power supply (SMPS) based mobile charging point with an efficiency of at least 70%.

xiv. The following minimum information must be included in a permanently printed label of the charge controller

- Manufacturers name
- Brand/Model
- Serial Number
- Maximum input current
- Maximum load current

xv. The efficiency of the charge controller must be at least 90%.

For MPPT type charge controller, charging efficiency must be at least 90% if load side connection is not available.

xvi. The charge controller must be equipped with a reverse current protection from the solar module side.

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

a. 10 milli-amperes at nominal system voltage (the non-critical indicators are turned off) for charge controller sized less than 20 ampere.

b. 30 milli-amperes at nominal system voltage for charge controller sized 20 ampere and above.

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

a. 20 milli-amperes at nominal system voltage (the non-critical indicators are turned off) for charge controller sized less than 20 ampere.

b. 100 milli-amperes at nominal system voltage for charge controller sized 20 ampere and above.

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

1.4 Lamps

1.4.1 General Requirements

The Lamp must be a White Light Emitting Diode (WLED) Lamp.

1.4.2 Required Documents

i. Lamp test certificate issued by third party or a statement provided by lamp manufacturer in their letter head describing the quality assurance that the lamps meet the technical requirements as defined in this chapter.

ii. Catalogue /Technical specification of the lamp and individual WLED used in the Lamp.

iii. 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.

iv. Local importer must provide a document of agreement between local importer and principle Lamp manufacturer, signed and stamped by authorized persons stating warranty period of at least 3 years and after sales services for their lamp. In case of local lamp manufacturer, it has to provide document stating warranty period of at least 3 years and after sales services for their lamp in their letter head signed and stamped by authorized person.

1.4.3 Technical Requirements

i. A viewing angle of individual WLED must be equal to or greater than 2*50 degree.

ii. The luminous Efficacy of individual WLED must be at least 100 Lumen/Watt

iii. The lamp driver circuit efficiency must be at least 80%.

iv. The Color Rendering Index (CRI) of the individual WLED must not be less than 60 and the color temperature must be in the range of 5000K to 6000K.

v. In the lamp with multiple WLEDs, the WLEDs used must not differ by more than 10% in individual WLED parameters (forward voltage and color temperature) at specified current.

vi. 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.

vii. The Luminous Yield of Lamp must be at least 80 Lumen/watt.

viii. The rated power of Lamp must be at least 1 (one) Watt and acceptable tolerance for all to be +/- 10%.

ix. The lamp must be protected against reverse polarity.

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

xi. The surface temperature of the WLEDs lamp must remain below 50°C during operation.

xii. The following minimum information must be included in the screen printed label of the lamp

a. Brand/Model and Serial Number

b. Nominal power in Watt

c. Nominal voltage

d. Lumen Output

xiii. The lamp and its enclosure should display good workmanship and should provide protection against dust, oil and smoke.

2 Additional Components of the Solar PV Systems

The following chapters set the technical requirements for the additional system components of the solar PV systems.

2.1 Solar inverter

2.1.1 Required Documents

Complete documentation for the inverter including the following must be provided

a. Installation instructions
b. Operating instructions
c. Technical specification and ratings
d. Safety warnings
e. Warranty for 2 years

2.1.2 Technical Requirements

i. The Inverter must have a rated AC output voltage of 220/230V ± 4% at battery operating voltage from DC 90% to 120% and maximum load current from 10% to 110% of the rated value.
ii. Output frequency of the inverter must be 50Hz ± 2%.
iii. Inverter efficiency when operating with resistive loads at full load must be at least 85%.
iv. The quiescent current drawn by the inverter must not exceed 2% of the rated current of the inverter.
v. The output waveform's Total Harmonic Distortion (THD) must be less than 5% at full load.
vi. The inverter must not produce noise more than 60db at 2m.
vii. Inverter or Inverter circuits must include
    a. i) Low battery shut down must be at battery voltage not less than 10.5 V for tubular plate battery in case of 12 V systems. For 24 V 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.

       ii) Batteries whose DOD can be considered up to 100% (hundred percent), Low battery shut down will not be applicable.

    b. Short Circuit protection of the output terminals.
    c. Reverse polarity protection on DC input terminals
    d. Appropriate indicators main, charging, inverter ON, short circuit and overload

v. The inverter must have either cooling system with fan or appropriate heat sink to avoid excessive heating.
vi. The inverter input and output terminals must have protection measures from

external contacts

vii. Inverter must be capable of Operating safely for at least 2 (two) seconds at 150 % of rated power.

viii. The minimum information must be included in the label of the inverter

a. Manufacturers' name and model
b. Rated power in Watt or VA
c. Input and output voltage in Volt and Frequency in Hz
d. Charging current, load current, power factor, efficiency
e. Inverter Type

ix. For inbuilt Charge Controller type Inverter, 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.

2.2 Solar pump

2.2.1 Required Documents

The manufacturers or installing companies has to provide test certificates including performance specifications according to IEC62253 and IEC61702 of Solar Pump from reputed third party agencies according to the national or international standard. The accepted quality certification systems are IEC Certificate or Certificate according to the ISO 9000 series or Quality assurance certificate issued by international reputed agencies like TÜV, Bureau of Veritas, UL or quality assurance certification from national or international laboratory/ institutions.

2.2.2 Technical Requirements

1. The pump can be centrifugal, positive displacement, progressive cavity, submersible or surface type meeting the safety standards of EN 809 and complies with IEC 60034-1.
2. Pump motor efficiency must be at least 60%.
3. The pump must have thermal protection against overload, reverse polarity and temperature
4. The pump or pump set must have control circuit with MPPT facility.
5. The pump must use standard submersible cable for submersible pump.
6. The pump or pump set must have provision of stopping operation under dry running or insufficient energy supply.
7. The pump must have protection against sand and silt.
8. Indelible label must be fixed on the pump, containing the following details
   - Name of the manufacturers or distinctive logo
   - Model and serial number

9. The motor and pump must be warranted for at least 2 years.
10. The pump must be manufactured with non-corrosive materials. Ceramic or equivalent non corrodible materials must be used for bearings. Rotors and impellers must be made of stainless steel with a minimum grade of AISI 304 or higher
11. Oil must not be used for lubrication.

Note At present, the testing facility of pump is not available, Therefore, RETS will verify the pumps parameters from the submitted documents.

2.3 Solar Prioritizer

The manufacturing company of the prioritizer has to ensure a charging algorithm to ensure that at least 35% of the energy comes from the PV module and that the battery/battery bank is not charged more than 60% from national grid.

3. 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.

4. 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.

5. 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.

6. 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. C20, C10, C5: An expression describing rate of discharge. The number indicates the number of hours to completely 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. Current at Maximum Power (Imp): The current at which maximum power is available from a PV module.

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

20. 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 25 ampere-hours from a fully charged 100 ampere-hours rated cell results in a 25% depth of discharge.

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

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

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

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. Overcharge: Forcing current into a fully charged battery.

32. Maximum rated current (Imp): Amperes produced by a photovoltaic module operating at the voltage of the I-V curve that will produce maximum power from the 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. Polycrystalline Silicon: A material used to make photovoltaic cells, which consist of many crystals unlike single-crystal silicon.

37. 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.

38. 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.

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

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

41. Self-Discharge: The rate at which a battery, without load, will discharge.
42. Short-Circuit Current (Isc): The current flowing freely through an external circuit that has no load or resistance; the maximum current possible.
43. Solar Home System: A "Solar Home System" (hereinafter called SHS) is a photovoltaic system used for providing primarily lighting services.
44. Solar Prioritizer: The Solar Prioritizer is a solar charger which can control the charging of the battery. It shall ensure the source for charging at least some portion from the PV Module and remaining from the grid.
45. Specific Gravity: The ratio of the weight of the solution to the weight of an equal volume of water at a specified temperature.
46. 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°C cell temperature.
47. State-of-Charge (SOC): The available capacity remaining in the battery, expressed as a percentage of the rated capacity.
48. 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.
49. Third party: Testing and Certification Institution duly accredited by the authorized entity of the government.
50. Voltage at Maximum Power (Vmp): The voltage at which maximum power is available from a photovoltaic module.
51. 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.

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). $LiCO_2$, $LiFePO_4$, batteries

Annex 2. Design guidelines for SSHS and SHS

Street Lamp

1.1 Required Documents:

1. Lamp test certificate issued by third party or a statement provided by Street Lamp manufacturer on their letter head describing the quality assurance that the lamps meet the technical requirements as defined in this chapter
2. A letter provided by principal Street Lamp manufacturer on their letter head mentioning the operational life of the Street Lamp to be at least 30,000 hours.
3. Catalogue and Technical Specifications of Street Lamp.
4. Local importer must provide agreement document between local importer and principal Street Lamp manufacturer, signed and stamped by authorized persons stating warranty period of at least 3 years and after sales services for their lamp. In case of local lamp manufacturer, it has to provide document stating warranty period of at least 3 years and after sales services for their lamp in their letter head signed and stamped by authorized person.

1.2 Technical Requirement:

1. The Street Lamp must be WLED type.
2. The Street Lamp should be equal or greater than 10Wp (≥10Wp).
3. Street lamp should have illumination not less than 0.5 Lux/Watt perpendiculars from the height of 9 m. The illumination should be uniform without dark rashes on the ground.
4. The viewing angle of individual WLED must be equal to or greater than 2*50 degrees.
5. The luminous efficacy of single WLED must be at least 100 Lumen/Watt.
6. The Color Rendering Index(CRI) of Individual WLED must not be less than 60 and the color temperature must be in the range of (5000-6000)°K
7. Must have Automatic dusk to dawn function.
8. Must have Driver circuit cum Charge Controller with not less than 85% efficiency.
5. In the lamp with multiple WLEDs, the WLEDs used must not differ by more than 10% in WLED parameters (forward voltage and color temperature) at specified current.
6. The lamp must be protected against reverse polarity
7. A heat-sink must be included such as metal etc, and connected using a suitable heat-transfer material.
8. The surface temperature of the WLED lamp must remain below 50°C during operation.
9. Must meet minimum IP65 standard.

10. The following minimum information must be included in the screen printed label of the WLED lamp
    a. Brand/Model/Serial number
    b. Nominal power in Watt
    c. Nominal voltage

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 Requirement*

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

1.3.2 *Technical Requirement*

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 250C.

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 Requirement

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 The Solar PV system design Consideration:

1. Must support for everyday use at least 4 hours lighting the light/s and 2 hours of single mobile charging.
2. Battery cycle 1000 (Ni-MH/Li-Ion)
3. Battery Efficiency: 80%
4. Array to load Ratio: 1:1
5. Peak Sun (Hour): 4.5
6. Insolation: 4500Wh/sqm/day
7. De-rating factor: 0.9
8. Columbic Efficiency: 0.95

1.6 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.

1.7 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.

Annex 2

SYSTEM SIZING GUIDELINES

1. Small Solar Home System(SSHS):

A "Small Solar Home System (SSHS)" (hereinafter) 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, radio as well as outlet for mobile phone charging. The system can have separate charge controller and battery or can have an integrated box with charge controller and battery. The SSHS should have its own delivery model.

Load: 3 no. of lamp (2W), charging option for one mobile phone (2.5 W) and one small radio (1W). The load consumption must not be greater than 60% of the generated power.

Panel Battery Ratio: 1: 1 to 1: 1.15 for lead acid battery with 12V system (Ah:Wp, i.e if the ratio is 1.15 , then for P, Wp of solar module, the battery capacity is 1.15 x P , Ah.)

For Ni-MH, Lithium Ion type the ratio must be in terms of (Watt peak to Watt Hour) Wp: WH: 1: (7.2-9.6)

Panel:

NEPQA Compliant 10Wp, Crystalline Silicon only.

Battery: NEPQA Compliant:

I. VRLA tubular:

II. Gel tubular

III. Nickel Metal Hydride

IV. Lithium Ion

Charge Controller:

Greater or equal to 3A, NEPQA Compliant PWM or MPPT and

Note: If mobile phone charger (SMPS) not integrated in the charge controller, company /importer must provide charge controller along with separate SMPS based mobile charger to the RETS for testing and verification.

Lamp:

NEPQA Compliant lamps

Wire:

All cables to be 1 mm2 size. Maximum length of cable between solar module and the charge controller to be 4 m (2 x4 m with return path).

Note: AC Cable will not be accepted. Use of AC cable or undersized cable will be considered as use of non NEPQA compliance product and will be penalized as per the QA & M guideline. Other specification of wire must be as per NEPQA.

Note: There must be provision for charging mobile phone and radio.

Mounting frame:

The panel must be firmly mounted in support structure to hold firmly the PV Module. The support structure should made of corrosion resistant metallic frame i.e. Aluminum with minimum thickness of 3 mm at 30 degree to horizontal and facing south. The height of pole must be at least 30 cm from the holding surface.

Installation:

The installation must be done by Solar Technician Level I and all the cables must be firmly wired using clips and hooks.

2. Solar Home System (20/55 Wp systems)

Load:

For 20 Wp system : 1 no. of lamp (4W), 2 nos. of lamp (3W), 1 no. of lamp (2W), charging option for one mobile phone (2.5 W) and one small radio (1W) and the load consumption must not be greater than 60% of the generated power.

For 55 Wp system : 6 nos. of lamp (3W), 2nos. of 4W lamp, charging option for two mobile phone (2.5 W) and one small radio (1W) and one LCD TV (15W) and the load consumption must not be greater than 60% of the generated power.

Wattage of LED lamp proposed is indicative, company can provide the different watt lamps of at least 2 W capacities as demanded by user and design the system accordingly.

Panel Battery Ratio: 1: 1 to 1: 1.15 for lead battery with 12V system (Ah:Wp, i.e if the ratio is 1.15 , then for P Wp of solar module, the battery capacity is 1.15 x P , Ah.)

For Ni-MH, Lithium Ion type the ratio must be in terms of (Watt peak to Watt Hour) Wp: WH: 1: (7.2-9.6)

Panel:

NEPQA Compliant 20/55 Wp, Crystalline or Thin Film.

Battery: NEPQA Compliant -

I. Flooded Lead Acid Battery

Vented: Tubular Plate

II. VRLA: Tubular Plate

a. Gel: Tubular Plate

b. Sealed Maintenance Free: Tubular Plate

c. Maintenance Free tubular Plate

III. Nickel Metal Hydride

IV. Lithium Ion

Charge Controller:

As required by charging current and load current with 50% safety factor, NEPQA Compliant PWM or MPPT.

Note: If mobile phone charger (SMPS) not integrated in the charge controller, company importer must provide charge controller along with separate SMPS based mobile charger to the RETS for testing and verification.

Lamp: NEPQA compliant lamps.

Wire:

Wires are sized according to the following table.

Dimension of cable for different sections of SHS, in mm2

Module size (Wp)/ cable sections	Module – Charge controller (UV Cable)	Charge controller-battery/ battery – junction box	Junction box - load
20	1.5	1.5	1
30	1.5	2.5	1
40	2.5	2.5	1
55	2.5	2.5	1

Note:

1. Size of cable used for SPV system is indicative. Therefore, company/importer can provide the appropriate or larger size of the cables using following formula for the system above 55Wp PV System.

Where, S - Required wire size (cross-sectional area of the copper wire in sq.mm),

L - Length of the wire in meters.,

Im – The maximum current in Ampere, and

ΔV – Maximum allowable voltage drop in percent. (i.e. 3%)

2. AC Cable will not be accepted. Use of AC cable or undersized cable will be considered as use of non NEPQA compliance product and will be penalized as per the QA & M guideline. Other specification of wire must be as per NEPQA.

Mounting frame:

The panel must be firmly mounted in support structure to hold firmly the PV Module. The support structure should made of corrosion resistant metallic frame i.e. Aluminum with minimum thickness of 3 mm at 30 degree to horizontal and facing south. The height of pole must be at least 30 cm from the holding surface.

Installation:

The installation must be done by Solar Technician Level - I and all the cables must be firmly wired using clips and hooks.

List of members signing NEPAL PHOTOVOLTAIC QUALITY ASSURANCE (NEPQA) 2015.rev1

S.N	Name	Designation	Organization	Signature	Remarks
1	Prof. Dr. Dinesh Kumar Sharma	Professor	Pulchowk, Campus		
2	Dr. Suresh Kumar Dhungel	Chief, Faculty of Technology	NAST		
3	Mukesh Ghimire	Solar Component Manager	AEPC		
4	Chaitnya Chaudhary	Engineer	AEPC		
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6	Madan Oli	Technical Manager	RETS		
7	Rabindra Lamichhane	Engineer	RETS		
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