1. DEFINITION AND ELIGIBILITY

1.1 A solar photovoltaic (PV) lantern is a lighting system consisting of a lamp, battery and electronics, all placed in a suitable housing made of metal, plastic or fibre glass, and a PV module. The battery is charged by electricity generated through the solar photovoltaic module. The lantern is basically a portable lighting device suitable for either indoor or outdoor lighting, covering a full range of 360 degrees. A lighting device which provides only unidirectional lighting will not be classified as a solar lantern in the present context.

1.2 Solar lanterns to be financed under the International Development Association and Global Environment Facility assisted Renewable Energy for Rural Economic Development (RERED) Project must have type test certificates from a testing and certification organisation acceptable to the Government of Sri Lanka and the World Bank stating that the lantern meets or exceeds the specifications given herein. Organisations accredited according to ISO 25 or equivalent standards will be acceptable. Solar lanterns or components that bear the Photovoltaic Global Approval Program (PV GAP) Mark or Seal will also be acceptable for use in the Project without additional certification requirements. PV GAP is a Geneva-based not-for-profit international organisation dedicated to the sustained growth of global PV markets to meet energy needs worldwide in an environmentally sound manner. (For more information see: http://www.pvgap.org/).

2. DUTY CYCLE

The solar lantern should provide a minimum of three hours of lighting per day under average daily solar radiation conditions of 5 kWh/sq.m. on a horizontal surface. The actual duration of lighting may vary depending on the location, season etc.

3. MODELS

The solar lantern should conform to one of the following models:

<table>
<thead>
<tr>
<th>Model</th>
<th>Lamp</th>
<th>Battery Capacity at C/20 Rate</th>
<th>PV Module Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>RERED 1 (MNES I-B)</td>
<td>CFL 5 W</td>
<td>12 V, 7.0 Ah</td>
<td>10.0 to 11.9 Wp</td>
</tr>
<tr>
<td>RERED 2 (MNES II-A)</td>
<td>CFL 7 W</td>
<td>12 V, 7.0 Ah</td>
<td>10.0 to 11.9 Wp</td>
</tr>
<tr>
<td>RERED 3 (MNES II-B)</td>
<td>CFL 7 W</td>
<td>12 V, 7.0 Ah</td>
<td>12.0 to 14.0 Wp</td>
</tr>
</tbody>
</table>

The individual specification for lamp, battery, electronics, module etc are given below.
4. **LAMP**

4.1 The lamp will be compact fluorescent (CFL) type with a rating of either 5 W or 7 W.

4.2 For 4-pin type CFLs a suitable preheating circuit must be provided.

4.3 The lamp should preferably be mounted in a base up configuration.

4.4 The minimum light output of the CFL should be 175 lumens for a 5 W lamp and 245 lumens for a 7 W lamp. The luminous efficacy of the CFL, inclusive of the power requirement of the inverter, must be either: (a) greater than 30 lumens/watt with any reflectors, lenses, covers or grids (if used) in place; or (b) greater than 35 lumens/watt without reflectors, lenses, etc in place. (These values are after allowing for any degradation noted in section 6.3 below)

5. **BATTERY**

5.1 The battery will be sealed maintenance free lead acid type.

5.2 The capacity of the battery will be a minimum of 7.0 Ah at 12 V at C/20 discharge rate at 20°C.

5.3 Eighty percent of the rated battery capacity should be between the low voltage and high voltage cut-off points.

6. **ELECTRONICS**

6.1 The inverter will be of quasi sine wave/sine wave type with a crest factor less than 1.7 and the frequency in the range of 20-35 kHz. Half wave operation is not acceptable.

6.2 The overall efficiency of the control electronics should be at least 80%.

6.3 No blackening or reduction in the lumen output by more than 10% should be observed after 1,000 ON/OFF cycles (two minutes ON and four minutes OFF is one cycle).

6.4 The idle current (i.e. the current consumed when the lamp is switched OFF and no charging is in progress) should not be more than 1 mA.

6.5 The PCB containing the electronics should be capable of solder free installation and placement.

6.6 Electronics should operate at 12 V and may optionally include temperature compensation for proper charging of the battery throughout the year.

7. **PV MODULE**

7.1 The PV module ratings given in section 3 (Models) above should be under Standard Test Conditions (STC) as defined in IEC 60904-1. The peak power output for thin film modules should be the value after light soaking.

7.2 Single-crystalline or poly-crystalline modules must be product tested and certified in accordance with IEC 61215 or equivalent specifications. If thin-film photovoltaic modules are used, they must be product tested and certified in accordance with IEC 61646 or equivalent specifications.
Crystalline or thin film modules that meet IEEE Specification 1262-1995 will also be acceptable.

7.3 The module should preferably have an arrangement (stand) for mounting at the optimum angle in the direction facing the sun.

7.4 In the case of thin film solar cell modules, the specified values refer to the power output after the initial degradation.

8. **ELECTRONIC PROTECTION**

8.1 Adequate protection is to be incorporated against damage by the application of voltage under open circuit conditions (e.g. when the lamp is removed or has failed and the lantern is switched ON).

8.2 Battery cut off and reconnects should be provided to protect it against overcharge and deep discharge conditions by incorporating a solid-state photovoltaic charge controller. The charge controller must incorporate one of the following charge control algorithms: (a) Constant Voltage, (b) Pulse Width Modulated, (c) On/Off series or shunt linear. Voltage regulation (high voltage disconnect voltage) set points should prevent excessive gassing of the battery. The set points must be factory pre-set with the set points applicable to the specified battery characteristics. If on/off control algorithm is used, regulation voltage of 14.4 V and a reconnect voltage of 13.4 V is recommended for flooded lead-acid batteries. It is recommended that circuitry to allow boost or equalisation charging the battery be provided.

8.3 A fuse should be provided to protect against short circuit conditions.

8.4 The charge controller must be equipped with reverse current leakage protection to prevent the reverse flow of current through the PV module. Blocking diodes or logic derived methods are both acceptable. If blocking diodes are used they must exhibit a low forward voltage drop.

8.5 Full protection against open circuit, accidental short circuit and reverse polarity should be provided.

9. **OTHER FEATURES/CONDITIONS**

9.1 The lantern should be provided with 2 LED indicators: a green light to indicate charging in progress and a red light to indicate deep discharge condition of the battery. The green light should glow only when the battery is actually being charged.

9.2 A good reliable switch suitable for DC use is to be provided on the lantern. A cable at least 5 metres long should be provided for inter-connection between the module and the lantern.

9.3 The following details should be marked indelibly on the lantern:
   (a) Name of the manufacturer or distinctive logo
   (b) Model number as specified in section 3 above
   (c) Serial number.

9.4 An Operation, Instruction and Maintenance Manual, in English, Sinhalese and Tamil, should be provided with the solar lantern.

   The following minimum information must be provided in the Manual:
   (a) About photovoltaics
(b) About the solar lantern
(c) About the PV module
(d) About the CFL
(e) About the battery
(f) Clear instructions on mounting of the PV module
(g) About the electronics
(h) About charging and the significance of indicators
(i) DO’s and DON’T’s
(j) Clear instructions on regular maintenance and trouble shooting
(k) Name and address of the person or service centre to be contacted in case of failure or complaint.

9.5 Components and parts used in the solar lantern should conform to the BIS specification, wherever such specifications are available and applicable.

9.6 Additional features such as a socket for powering another appliance such as a fan or radio may be provided along with the switch. This is however purely optional. If such features are provided, they should not interfere with the independent switching on and off of the lantern.

9.7 The PV module will be warranted for the minimum period of ten (10) years from the date of supply and the lantern (including the battery) will be warranted for a minimum period of one (1) year from the date of supply. The Warranty Card to be provided with the system must contain the details of the system supplied, as given in Annex 1.

9.8 Customer complaints shall be resolved promptly. If any lantern is found defective during the warranty period, the supplier shall replace or repair the same within ten days from the date of intimation sent to the supplier at the supplier’s cost. Suppliers may also provide additional information about the system and conditions of warranty as necessary.

9.9 A sample lantern shall be submitted to the Administrative Unit, RERED Project along with test certificates providing evidence of compliance with specifications (see section 1.2 above). Lanterns passing the Design Verification carried out by the Administrative Unit will qualify to enter the RERED Credit Programme.

9.10 Suppliers shall forward to the Administrative Unit, RERED Project full details of make, model and serial numbers (as per section 9.3 above) of each consignment of lanterns that are imported. If manufactured or assembled locally, the details shall refer to each consignment of lanterns leaving the factory. This information shall be furnished to the Administrative Unit before the lanterns are sold in the market. Suppliers shall permit the Administrative Unit or its authorised agents to examine inventories of lanterns carried by them or their dealers.
Annex 1

Format of Warranty Card to be provided with each Solar Lantern

1. Name and address of supplier, including telephone number
2. Name and address of the manufacturer
3. Date of supply of the system
4. Warranty expiry date
   (a) PV module
   (b) Balance of system components
5. Details of PV module(s) supplied with the system
   (a) Make (name of the manufacturer) and model
   (b) Serial No(s)
   (c) Wattage of the PV module(s) under STC
6. Details of battery supplied with the system
   (a) Make (name of the manufacturer) and model
   (b) Rated V and Ah capacity at C/20 rate at 20ºC.
7. Details of lamp
   (a) Make (name of the manufacturer) and model
   (b) Wattage
8. Details of electronics and other balance of system components
   (a) Make (name of the manufacturer)
   (b) Details
9. Designation, address and telephone number of the person to be contacted for claiming warranty obligations
10. Contact details for unresolved complaints:
   Administrative Unit, RERED Project
   DFCC Bank, 73/5 Galle Road, Colombo 3
   Telephone: 440366, Fax: 440376

…………………………
(Signature)
Name
Designation
Date
(Rubber stamp of supplier)