SUNLIGHT
Reliable Battery Solutions

Installation, Commissioning and Operating Instructions

for Renewable Energy Storage applications

RES SOPzS 2V Cells - Vented Lead Acid Batteries

Assembly and CE-marking by: ..... Date: ...../...../.....

Commissioning by: ..... Date: ...../...../.....

Number of cells: ..... Type: .....

Safety Instructions

Read the instructions carefully and place them close to the battery.

Work on batteries to be carried out by skilled personnel only!

While working on batteries wear safety glasses, goggles and protective clothing! Comply with accident prevention rules as well as with EN 50 272-2, VDE 0105 part 1!

No smoking!

Do not expose batteries to naked flames, glowing embers or sparks, as it may cause an explosion.

Acid splashes in the eyes or on the skin must be washed with water. In case of accident consult a doctor immediately!

Clothing contaminated by acid should be washed in water.

Risk of explosion and fire.
Caution: Metal parts of the battery are always under voltage. Do not place tools or other metal objects on the battery!
Avoid short circuits!

Electrolyte is highly corrosive.

Batteries and cells are heavy.
Ensure secure installation!
Use only suitable handling equipment e.g. lifting gear in accordance with VDI 3616.

Dangerous voltage!

Batteries with this symbol can be recycled.

Treat batteries as special waste.
Do not mix them with other industrial or household waste.
Recycling can be achieved through a recognized company for battery recycling or by returning them to the manufacturer, depending on the agreement you have made.

Usage of the battery which does not comply with the OPERATING INSTRUCTIONS, repairs carried out with non-approved spare parts or unauthorized interference with the battery will invalidate any claim for warranty.

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1. Delivery and Storage

1.1 Receiving Inspection

Inspect for missing components. Check against the packing documents. Inspect each package or pallet for integrity and electrolyte leakage. Record receipt date and inspection data results, and notify manufacturer of any damage. Take photographs if necessary.

1.2 Storage

Store the battery in a dry, clean, ventilated and preferably cool and frost-free location. Do not expose the cells to direct sunlight as damage to the container and cover may occur.

Do not stack one pallet above the other. Avoid storing unpacked cells on sharp-edged supports. Storage on a pallet wrapped in plastic material is permitted except in rooms where the temperature fluctuates significantly, or when high relative humidity can cause condensation under the plastic cover. With time, this condensation can cause a whitish hydration on the poles and lead to high self-discharge by leakage current.

Protect the batteries from any risk of electric shock resulting from short-circuiting by conductive objects or from the building up of conductive dust. It is recommended to have the same storage conditions within a batch, pallet or room. Since the batteries are supplied charged, storage time is limited. In order to easily charge the batteries after prolonged storage, it is advised not to store them for more than 3 months at 20˚C, 2 months at 30˚C, 1 month at 40˚C. A refreshing charge shall be performed after this period as a full charge (see p.3.2.1). Failure to observe these conditions may result in significantly reduced capacity and service life. Record dates and conditions for all charges during storage.

1.3 Unpacking and Handling

Lifting heavy cells can be made from the cell poles. Both poles have to be used. The lifting force shall be applied vertically up and equally on each of the poles. Never drag or roll the battery since damage will be caused. The batteries are fully charged before shipment. Do not short circuit. Check for evidence of leakage. All cells with visible defects such as cracked jars, loose terminal posts, or other unrecoverable problems shall be rejected.

2. Installation and Commissioning Charge

2.1 Room and Installation Design

The electrical protective measures or devices, the accommodation and ventilation of the battery installation must be in accordance with the applicable rules and governmental regulations. EN 50272-2 and EN 50110-1 should be observed. The battery should be installed in a clean and dry area. Avoid placing the battery in a warm place or in direct sunlight. The location or arrangement of cells should result in no greater temperature difference of 3 ˚C between cells within a series-connected string at a given time. Avoid conditions that result in spot heating or cooling, as temperature variations will cause electrical unbalance to the battery. For better cooling, ensure the installation allows adequate air flow around batteries. The layout of the room must allow easy access to the batteries. Provide adequate space and illumination for inspection, maintenance, testing, and cell/battery replacement. Space should also be provided to allow the operation of lifting equipment and taking measurements (cell voltage and temperature).

2.2 Racks and Mechanical Stability

Calculations should be performed to ensure that floor loading capabilities are not exceeded. Seismic forces shall be considered when applicable. Approved, insulated battery racks or trays with lateral force on the sidewalls in order to avoid an excessive bulging of the battery cell containers are recommended for proper installation. **The installation should provide adequate structural support and the minimum possible vibration.**

2.3 Cells in Parallel Strings

RES SOPzS cells may be connected in parallel to provide higher current capability. In the case of parallel connected strings, use batteries of the same capacity, design and age only with a maximum of 4 parallel strings. If more than 4 strings are required, consult SYSTEMS SUNLIGHT S.A. The resistance of the cables in each string must be the same, e.g. same cross-section, same length. In addition, each string should be equipped with disconnect capabilities for maintenance and safety purposes.

2.4 Preliminary Control

Check for leakage evidence. All cells with visible defects such as cracked jars, loose terminal posts, or other unrecoverable problems shall be rejected. Before installation, in case the surface of battery container is dirty, wash with soapy water only.

Carry out OCV (Open Circuit Voltage) measurements on each individual cell to check their compliance against the variation and absolute voltage criteria:

- The OCV must not deviate from average more than ± 0.025V for 2V cells
- The OCV must not be lower than 2.03V

In case of non compliant measurements, consult SYSTEMS SUNLIGHT S.A..

Note: OCV of a fully charge cell is ~2,08V. Per 10% Depth of Discharge (DOD) the voltage is reduced by ~12.5mV. (e.g. OCV of 2,03V corresponds to 40% discharged cell).

2.5 Electrical Connections

Ensure that the cells are installed in the correct polarity. Check that all contact surfaces are clean. If required, clean with a brass brush/pad. You may lubricate slightly the inserts and connections with silicone grease. Petroleum-based lubricant is not recommended. Tighten the terminal screws using a torque loading of 22 Nm. Electrical connections to the battery and between cells on separate levels or racks should be made to minimize mechanical strain on battery terminal posts. For systems where the total battery voltage is measured at the controller, use oversized cables to the battery in order to minimize the voltage drop.

Check the battery's total voltage. It should match the number of cells connected in series. If the measurement is not the expected, recheck the connections for proper polarity.

Batteries with a nominal voltage >75 V require an EC conformity declaration in accordance with the low voltage directive (73/23/EEC). This demonstrates the fulfillment of the EU requirements of the battery that bears the CE marking. The company installing the battery is responsible for the declaration and applying the CE marking. For future identification, apply individual cell/unit numbers in sequence starting from one end of the battery. Also apply identification numbers for the parallel strings. Connect the battery to the DC power supply, after ensuring that the polarity is correct, the charger switched off, the battery fuses are removed and the load is disconnected.

2.6 Instrumentation

For large installations consider the use of instrumentation for measurements and alarm. These include Voltmeter, Ammeter, Ah counter, High- and low-voltage indicators, Ground fault detector(s) and Temperature sensor(s) for the battery and the ambient air. For smaller installations use portable test equipment. The temperature sensors shall be fixed on the battery units (side wall or negative pole). The use of monitoring and recording systems is mandatory in “Hybrid” systems.

2.7 Commissioning Charge

The initial charge is very important for the future battery operation and the battery’s service life. It is performed as a full charge in paragraph 3.2.1. Keep the records in the battery’s logbook.

3. Operation in Respect to the RES Design

In “Stand-alone” systems, the renewable source - basically PV arrays - is the only charging source available for the battery. In some systems, an external source - like diesel - can be used but this is not within the basic design principle, e.g. the source is engaged only intermittently and manually by the user in order to serve excessive loads or to maintain the batteries.

Two types of charge controllers can be used:

- On-Off PV controllers. The controller interrupts the charging current from the PV array (off state) when the battery voltage reaches the high regulation point (e.g 2.45Vpc) and connects it back (on state) when the voltage drops to the low regulation point (e.g. 2.35Vpc). This type is not recommended for VRLA batteries.
- Constant Voltage type (PWM method is also included here). Once the battery voltage reaches the regulation point, the controller limits the charging current to keep the voltage constant at this level, given that enough power is available from the renewable source. Two sub types may be defined here:
  - One voltage step controller: There is only one regulation point.
  - Two voltage steps controller: There are two regulation points. Initially the controller maintains an elevated voltage to recharge the battery fast (absorption stage) and then, after certain time or other criteria, it steps back to a lower voltage to prevent unnecessary overcharging (floating stage).

In “Hybrid” systems, the renewable source size is smaller than the application load. There is always an independent source available - diesel or grid – to recharge the battery in every cycle, once a minimum state of charge has been reached. The same source can be also engaged, either automatically at regular intervals or manually when required, to maintain the battery with equalizing charges. Only Constant Voltage controllers (usually with two voltage steps) shall be used here.

3.1 Discharging

No restriction on the discharge current is required, as far as the connections are properly sized and the battery temperature stays within the allowable limits.

The maximum allowable discharge per cycle (Max Daily DoD - MDDOD) is:

- 25% for Stand-alone
- 60% for Hybrid systems

For discharge rates lower than I_{10}, the MDDOD is expressed in % of the C_{10} value. For example, a cell RES 7 SOPzS 1270 has C_{10} = 900 Ah therefore a 60% MDDoD means 540 Ah extractable per day. The maximum allowable DoD (MDOD) is 80% of the maximum available capacity for all systems, unless otherwise has been approved by SYSTEMS SUNLIGHT.

Overdischarge Protection

The MDOD limit control should not be implemented solely through control systems based on Ah-counters (integrating the ampere-hours into and out of the battery). Monitoring the battery voltage against the low-voltage disconnect setting (LVD) should always be included. The MDDOD limit control - for hybrid applications - can be realized either by Ah-counters control units or/and by battery voltage monitoring. For Stand-alone systems see the note below for the Array to Load ratio. The graphs at the end of this document present the battery voltage to DoD relation as a guidance for the initial LVD settings (first-try settings). The system designer or installer shall adjust and confirm them upon the actual conditions of the system. For systems where the voltage is measured at the controller and not on the battery, the voltage drop on the connections to the

battery shall be considered. For critical systems with the load directly connected on the battery, an alarm or other method of user feedback must be included to give information about the battery status when DoD exceeds 60 to 80%.

Array to Load ratio for Stand-alone systems

In Stand-alone systems, the renewable source shall be sufficiently oversized against the application load in order to avoid excessive cycling near the MDOD which limits dramatically the battery's life expectancy. The ampere hour output of the PV array (or other renewable source) over the load ampere hours for the minimum design month (month with minimum PV output) should be at least 1.3 (acc. to IEEE1013) to recharge the battery while the daily load is supplied.

Low-voltage reconnect (LVR) for Stand-alone systems

The battery voltage at which the load is reconnected after a low-voltage disconnect shall be above 2.3 Vpc.

3.2 Charging

3.2.1 Full Charge

The full charge is a prolonged charge at an elevated voltage, performed under the supervision of the user. It lasts until certain full charge criteria are fulfilled but not outside certain minimum and maximum duration limits. It is mainly used as:

- Commissioning charge after installation (§ 2.77)
- Corrective Equalizing charge (§ 3.2.2.2)
- Preparation charge before a capacity test (§ 6)
- Refresh charge during long storage period (§ 1.2, 7)

During charge, the battery temperature shall be continuously monitored. It should never exceed 45ºC, otherwise the charge shall be interrupted for a sufficient time in order to cool down the battery.

Case 1) With external charger of IU - characteristic.

For the commissioning charge the current shall be limited to 1 x I_{10} Amps.

Battery temperature	Voltage settings	Min and max charging times
15-30ºC	2.45 – 2.50 V	24h – 48 h
30-40ºC	2.40 – 2.45 V	24h – 48 h
0-10ºC	2.50 – 2.55 V	24h – 48 h

Full charge criteria:

- For each individual cell - Voltage:
  - o Stability in the last 4 hours: voltage shall not change by more than 0.02V
  - o Deviation at the end of the charge: minimum cell voltage shall not deviate by more than 0.15V from the average.
- For each individual cell - Electrolyte density:
  - o Stability within the last 4 hours: densities shall not rise more than 0.01 gr/ml
  - o Deviation at the end of the charge: densities shall not deviate by more than ±0.015 gr/ml from the average.
- For the charging current:
  - o Stability in the last 4 hours: current shall not change by more than ±25%.

Case 2) With external charger of IUI or I - characteristic.

Using an IUI or I charger that can charge the battery with constant current at elevated voltage, higher than 2.50Vpc and up to 2.80 Vpc.

- Bulk charge current limitation: 2.0 x I_{10}
- Voltage settings for U phase: 2.33 – 2.40 V
- Gassing charge current limitation: 0.3 x I_{10} (3A per 100 Ah of nominal capacity)
- Minimum and maximum charging time at gassing phase: 5 h – 8 h (*)

Full charge criteria (*):

- For each individual cell - Voltage:
  - o Stability in the last 1 hour: voltage shall not rise by more than 0.02V.
  - o Deviation at the end of the charge: minimum cell voltage shall not deviate by more than 0.12V from the average.
  - o Absolute value: it shall be above 2.6V
- For each individual cell - Electrolyte density:
  - o Stability within the last 4 hours: densities shall not rise more than 0.01 gr/ml
  - o Deviation at the end of the charge: densities shall not deviate by more than ±0.015 gr/ml from average.

(*) In special cases when the maximum charging time has elapsed but the full charge criteria have not been achieved yet, the Equalizing program shall be continued with the following charge & pause profile:

- Charge for 2h with 0.3 to 0.5 x I_{10} (3A to 5A per 100 Ah of nominal capacity)
- Repeat charge & pause profile until the full charge criteria are fulfilled or a maximum of five charge & pause cycles has been reached.

Case 3) Using the solar controller.

Connect the battery to the controller and leave it for 1-2 weeks while the application load is disconnected. Full charge criteria are not applicable here. Use the following voltage settings:

For On-Off controllers			
Temperature range	-20 to 0˚C	0 to 35˚C	>35˚C
High disconnect voltage (Vr)	2,60V	2,50V	2,45V
Low restart voltage (Vrr)	2,40V	2,35V	2,30V
For Constant Voltage controllers			
Temperature range	-20 to 0˚C	0 to 35˚C	>35˚C
Regulation voltage (Vr)	2,55V	2,45V	2,40V

3.2.2 Equalizing

3.2.2.1 *Functional Equalizing*

During a cycling operation, the target is to achieve an almost complete recharge (100% SOC) after every discharge cycle; otherwise a permanent capacity decrease and acid stratification phenomena will threaten the battery's state of health. This is not always possible in Stand-alone applications where the RES source depends on the weather conditions and the load may exceed the expected level. In this case, a proper "Array to Load ratio" (as given in paragraph 3.1) is critical for the life expectancy of the battery. For Hybrid systems with diesel generator (mainly telecom hybrid systems), the charging source is always available but the boost charging time is restricted to achieve a more efficient utilization of the diesel. In both cases, a scheduled (functional) equalizing charge shall be performed at regular intervals (see § Normal operation charging) to protect the battery from sulphation and lagging cells.

- Equalizing frequency is adjusted according to the charge deficit. The less complete the daily recharge is, the more frequently the equalizing is required (see § Normal operation charging)
- The charge duration is fixed.
- The values of the voltage settings are the same to those of a normal recharge.

3.2.2.2 *Corrective Equalizing*

Equalizing charges are also required after incidents of excessive stress for the battery (deep discharges with inadequate charges) or when the individual cell voltages show excessive deviation from the average (lagging cells and sulphation problems).

Should the voltage in individual cells deviate from the average value more than the following limits, perform an equalizing charge:

Battery state	2V cells
At floating	-0.1V / +0.2V
At the end of the normal charge, while current is stable	-0.2V / +0.35V
During discharge, while DoD is between 5 and 25%	± 0.04V
During discharge, while DoD is between 25 and 60%	± 0.06V
At rest, 16h after a Functional Equalizing charge	± 0.025V

Corrective Equalizing is performed as a Full Charge in paragraph 3.2.1. If the voltages are still out of the limits, contact SYSTEMS SUNLIGHT Customer Service Dept. A service contract with SYSTEMS SUNLIGHT S.A. is recommended.

3.2.3 Normal operation charging

The following charging voltage settings are optimum values, so the battery is not heavily undercharged or overcharged. A good indicator to check this, is the percentage of overcharge per cycle (charging factor) within a long period of operation (a month to a year). Deviations from the charging factors given here, prompt to check the charging settings and the overall system operation again:

- >110% for Stand-alone systems with Maximum Daily DOD less than 5%
- 110% to 125% for Stand-alone systems with MDDOD more than 5%
- 110% to 115% for Hybrid systems without air lift system.
- 104% to 107% for Hybrid systems equipped with air lift system.

3.2.3.1 *Settings for Stand-alone systems*

The settings shall be adjusted according to battery temperature.
Temperatures are averaged over one month:

Controller type	Setting	-20 to 0˚C	0 to 15˚C	15 to 35˚C	>35˚C
Constant Voltage - one step	Vr	2,55V	2,50V	2,45V	2,40V
Constant Voltage - two steps	absorption max. 4 h per day	2,60V	2,55V	2,50V	2,45V
	float	2,50V	2,45V	2,40V	2,35V
On-off	High voltage (Vr)	2,60V	2,55V	2,50V	2,45V
	Low voltage (Vrr)	2,40V	2,35V	2,35V	2,30V

For systems with oversized PV array and low MDDOD (<5%), use lower settings (§ 3.3). Functional equalizing charges are required in periods with marginal "Array to Load ratio", less than 1.3. Typical frequency is 1 to 6 times per year.

3.2.3.2 *Settings for Hybrid systems*

Daily charge after discharge:

Only constant voltage controller is permitted. The absorption voltage setting shall be adjusted according to the battery temperature. Temperatures are averaged over one month:

Temperature	-20 to 0˚C	0 to 15˚C	15 to 35˚C	>35˚C
Absorption voltage:	2,55V	2,50V	2,45V	2,40V

The absorption time setting can be selected between 4 to 12 hours.
The frequency of the functional equalizing charge shall be adjusted accordingly:

Absorption time setting for the daily charge		4-6h	6-8h	8-10h	10-12h
Do one Equalizing every	if daily DoD is within 40-60%	7 days	14 days	21 days	28 days
	if daily DoD is within 20-40%	10 days	20 days	30 days	40 days

The Functional Equalizing for systems without air lift includes a gassing stage with constant current for a fixed time:

- Before the gassing stage, charge the battery with the absorption voltage. Continue charging until the current drops below 0.4 x I_{10} A. Then, charge with current 0.4 x I_{10} (4A per 100 Ah of nominal capacity) for 5 hours. The battery voltage exceeds 2.60V/cell.

For systems equipped with air lift pump, the Functional Equalizing can be performed according the IU charge characteristic:

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- Option 1 (acc. to IU-profile): Charge for 16 hours with constant voltage at +0,05 V above the Absorption voltage setting.
- Option 2 (acc. to IUI-profile): Before the gassing stage, charge the battery with the absorption voltage. Continue charging until the current drops below 0.2 x I_{10} A. Then, charge with current 0.2 x I_{10} (4A per 100 Ah of nominal capacity) for 5 hours. The battery voltage exceeds 2.60V/cell.

Functional Equalizing regime and electrolyte density
A Functional Equalizing regime (frequency and duration) is sufficient when the electrolyte density has reached its rated value for each cell at the end of the charge.

3.3 Operation at no or very Low Load

When there is little or no load connected to the system for long periods (more than 1 month) while the battery remains connected, the normal charging settings in paragraph 3.2 are too high and result in unwanted overcharging. The same applies to Stand-alone systems with oversized PV array and very low MDDOD (<5%) (e.g. remote Telecom transmitters).
Use the following settings. Temperatures are averaged over one month:
For Stand-alone systems:

Controller type	Setting	-20 to 0˚C	0 to 15˚C	15 to 35˚C	>35˚C
Constant Voltage - one step	Vr	2,40V	2,35V	2,30V	2,30V
Constant Voltage - two steps	absorption max. 4 h per day	2,40V	2,35V	2,30V	2,30V
	float	2,35V	2,30V	2,25V	2,25V
On-off	High voltage (Vr)	2,40V	2,35V	2,30V	2,30V
	Low voltage (Vrr)	2,20V	2,20V	2,20V	2,20V

For hybrid systems:

- When only PV is engaged: use settings as in “Constant Voltage – one step” case above
- When only diesel is engaged (continuously): use settings as in “Constant Voltage – two steps \ float” case above.

3.4 Temperature Limits

All technical data apply for the nominal temperature of 20ºC. The ideal operating temperature range is 20ºC to 25ºC. The recommended operating temperature range is 15ºC to 35ºC. Higher temperatures reduce operating life. A maximum temperature of 50ºC must not be exceeded. In hybrid applications the yearly average of battery temperature should be less than 30˚C.
Subzero temperatures may cause electrolyte freezing and irreversible damage when the battery’s depth of discharge (DoD) is high. The minimum safe temperature Vs DoD is given below:

DoD (% to C_{10} - DIN value)	0% - 20%	20% - 40%	40% - 60%	60% - 80%
Freezing point	-35ºC	-25ºC	-17.5ºC	-12.5ºC

The system designer/installer shall consider countermeasures like thermal insulation, increasing the battery capacity or increasing the minimum system voltage. In Stand-alone systems it is recommended to use controllers with adjustable LVD setting for the battery temperature (higher LVD for lower temperature).
During operation, the temperature difference between individual cells should be below 3ºC.

3.5 Current limits

The maximum charging current during the bulk charging is 3 x I_{10}, while the battery voltage is below the gassing voltage of 2,40V x number of cells.

3.6 Ripple currents

During recharging up to 2.40 V/cell, the effective value of the AC ripple current may reach temporarily at maximum 10 A /100 Ah C_{10} nominal capacity. After recharging and at float charge in stand-by or buffer operation, the effective value of the AC ripple current must not exceed 5 A /100 Ah C_{10} nominal capacity.

3.7 Electrolyte and Topping up with Water

The electrolyte is diluted sulphuric acid. The rated specific density of the electrolyte in a fully charged state is based on 20˚C and the "MAX" electrolyte level is 1,24 kg/l with a maximum deviation ± 0,01kg/l. Density changes with temperature. It drops when temperature rises and vice versa. The temperature correction factor is -0,0007 kg/l per ˚C. Density increases when the electrolyte level becomes low due to water decomposition. Density at MIN mark is approx 1.26 kg/l. The water decomposition rate depends on several factors like daily DoD, charging factor, temperature and battery age. The user shall top up with purified water the latest when the level has dropped to the “MIN” mark. Only purified water as specified under DIN 43 530 Part 4 (maximum conductivity 30 S/cm) must be used. The top up level is designated with “MAX” mark.

3.8 Air Lift Operation (if it is available)

Operate the air lift system daily, during and for one hour after the charge. In order to save energy and reduce the water loss, the air supply can be made in repeated cycles, like 4 minutes ON and 8 minutes OFF. The recommended air flow is 20 to 30 l/h/cell.

4. Battery Maintenance

Visual inspection and cleaning instructions: Check for leakage evidence and any visible defects such as cracked jars, loose terminal posts or oxidized connectors. To avoid leakage currents and the associated risk of fire, keep the battery dry and clean. Clean with clear water. Do not use any solvents or detergents as they can cause permanent damage to container or lid. Avoid electrostatic charges. For the systems equipped with airlift function, operate the airlift to check if all cells are properly bubbling.
Topping up: Top up with water at regular intervals to secure that electrolyte level never drops below “MIN” mark. Follow the instructions in §3.7.
Six-monthly maintenance. For Hybrid systems, perform the maintenance after a Functional Equalizing charge:

- Visual inspection. Clean if necessary.
- Measure/record the battery voltage.
- Measure/record the voltage of each cell.
- Measure/record the electrolyte density and temperature of each cell.
- Confirm that the max daily DoD does not exceed the allowed limit.
- Confirm that the max DoD does not exceed the allowed limit.
- Confirm that the charging factor is within acceptable limits.
- Confirm that charge settings correspond to the recommended ones.
- Check if corrective equalizing is applied according to 3.2.2.2

Yearly maintenance. Further to the 6-monthly maintenance, do the following:

- Check if connectors are firmly tightened.
- Inspect the racks for corrosion or loss of integrity.
- Check if ventilation is sufficient.

5. Faults

Should faults be detected in the battery or the charging device, contact SYSTEMS SUNLIGHT Customer Service immediately. Measured data simplify fault detection and elimination. A service contract with SYSTEMS SUNLIGHT S.A. will detect faults in time.

6. Testing

Tests must be conducted according to IEC 60 896 - 21. Check that the battery is fully charged. Before testing new batteries, ensure that a sufficient commissioning charge has been applied and the battery is fully charged.

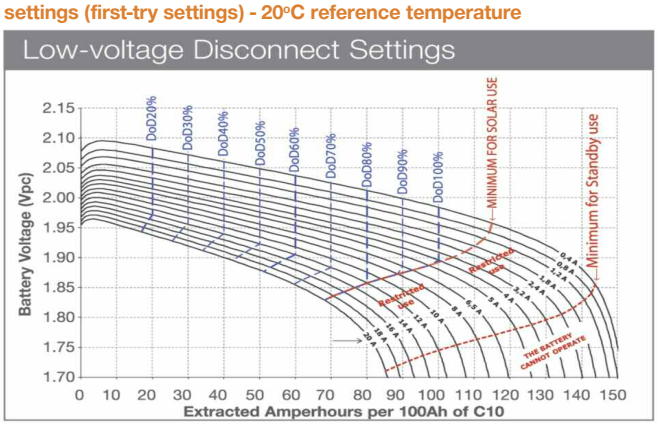
7. Storage and Taking out of Operation

If filled lead acid accumulators are to be taken out of operation for a long period of time, they must be placed fully charged in a dry, frost-free room. To avoid damage, perform periodical equalizing charging (see 3.2.1) or permanent float charging.

8. Transport

RES SOPzS cells are protected against short-circuit. If properly packed, batteries are no dangerous goods according to the international regulations for dangerous goods on road and on rail (ADR and RID).

Battery Voltage in relation to DoD as a guidance for the initial LVD settings (first-try settings) - 20ºC reference temperature



Notes:

- The minimum voltage, for standby use, represents the maximum available capacity.
- The minimum voltage, for solar use, represents the 80% of the maximum available capacity. It is the lower LVD setting except in special applications and after Sunlight’s approval.
- The DoD 60% line, represents the minimum voltage setting to control the end voltage of each discharge in hybrid applications. It’s always recommended to implement a supplementary control by Ah counter.

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