PowerSafe®

Sustainable Solutions

PowerSafe® TS

Operation Guide for Solar Applications

EnerSys®

Power/Full Solutions

Safety precautions
Batteries give off explosive gasses. They are filled with dilute sulphuric acid, which is very corrosive. When working with sulphuric acid, always wear protective clothing and glasses. Exposed metal parts of the battery always carry a voltage and are electrically live (risk of short circuits). Avoid electrostatic charge. The protective measures according to EN 50272-2 and IEC 62485:2010 must be observed.


Note operating instructions


Danger. Cells are heavy.
Make sure they are safely installed. Only use suitable transport and lifting equipment


Risk of explosion or fire.
Avoid short circuits


When working on batteries, wear safety glasses and protective clothing


Electrical hazard


Wash all acid splash in eyes or on skin with plenty of clean water and seek immediate medical assistance


No smoking.
Do not allow naked flames, hot objects or sparks near the battery, due to the risk of explosion or fire


Electrolyte is highly corrosive

Recycling and disposal of used batteries


Used batteries contain valuable recyclable materials. They must not be disposed of with the domestic waste but as special waste. Modes of return and recycling shall conform to the prevailing regulations in operation at the site where the battery is located.

Warranty
Any of the following actions will invalidate the warranty - non-adherence to the Installation, Operating and Maintenance Instructions. Repairs carried out with non-approved spare parts. Applications of additives to the electrolyte. Unauthorised interference with the battery.

Handling
TS batteries are supplied filled & charged or moist charged, and must be unpacked carefully to avoid short-circuit between terminals of opposite polarity. The cells are heavy and must be lifted with appropriate equipment.

Keep Flames Away
Discharge any possible static electricity from clothes by touching an earth connected part.

Tools
Use tools with insulated handles.
Do not place or drop metal objects onto the battery.
Remove rings, wristwatch and metal articles of clothing that might come into contactwith the battery terminals.

1. Introduction

1.1. Benefits

The specific benefits of PowerSafe® TS batteries for renewable energy applications are as follows.

- **Cycling** (one “cycle” consists of a discharge, of any depth, followed by a recharge)
- **Overcharge ability**
- **Cycling in state of discharge**
- **Low rate of self-discharge**
- **Large electrolyte reserve**

PowerSafe® TS cells are designed for applications where the battery may undergo repeated cycling with daily depths of discharge of up to 35% of capacity C_{120} (such as rural settlements, communications systems and lighting systems etc.).

1.2. Cell Design

The PowerSafe TS range of single cells offers high performance, long-life solutions for renewable energy applications.

PowerSafe TS cells are based on proven vented technology and designed for renewable energy applications that require maximum cycle life with the highest level of reliability. They are particularly suitable for use in solar energy installations, ensuring a continuity of electrical supply during the hours of darkness or during periods of reduced sunshine.

The Powersafe TS are flooded batteries consuming water and require regularly maintenance watering (see section 5). Demineralised water needs to be added at intervals which depends on operating conditions and electrolyte reserve.

Reduced maintenance is achieved through the use of additional electrolyte, which means cells only have to be topped-up once a year. This helps to keep down maintenance costs and makes them an ideal solution for many remote or unmanned locations.

Tubular positive plates are widely used in batteries for particularly demanding applications. In the TS range they have been optimised to give an extended cycle life and increased capacity.

1.3. Features & Benefits

- Capacities from 300Ah to 4580Ah at the 120 hour rate
- Products available filled & charged or moist charged
- Up to 5200 cycles to 25% depth of discharge
- Minimal maintenance required (topping-up required only once a year)
- Excellent operational safety including fully insulated connectors and terminals, acid-proof flame arrestor plug for each cell and protection of polarities during transport

1.4. Capacity

Capacity is the number of Ah a battery can supply for a well-defined current and an end of discharge voltage.

Capacity varies with the discharge time, discharge rate and temperature.

Example:
Capacities for PowerSafe TYS 5 cell are as follows:

Discharge time	50h	100h	120h
End voltage	1.85Vpc	1.85Vpc	1.85Vpc
Capacity at 25°C	739Ah	790Ah	802Ah

The nominal capacity of PowerSafe® TS cells for renewable energy applications is as follows:

Capacity Ah	Current A	Discharge period h	End voltage V/cell
C_{120}	I_{120}	120	1.85V

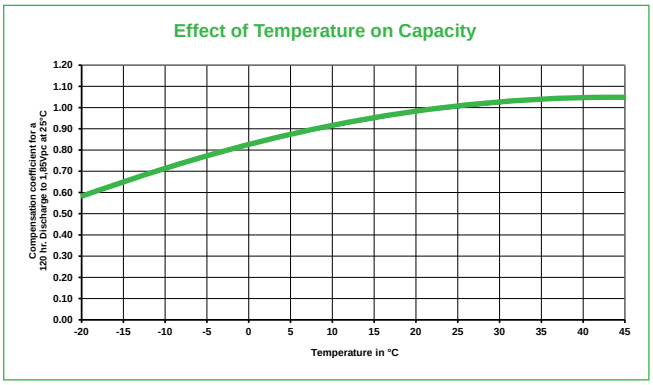
Discharge rate:
Is the ratio of discharge current divided by battery capacity.

Depth of discharge (DOD):
Capacity removed from the battery compared to total capacity.
It is expressed as a percentage. The battery will be sized for solar applications with a DOD <80% for the autonomy required.

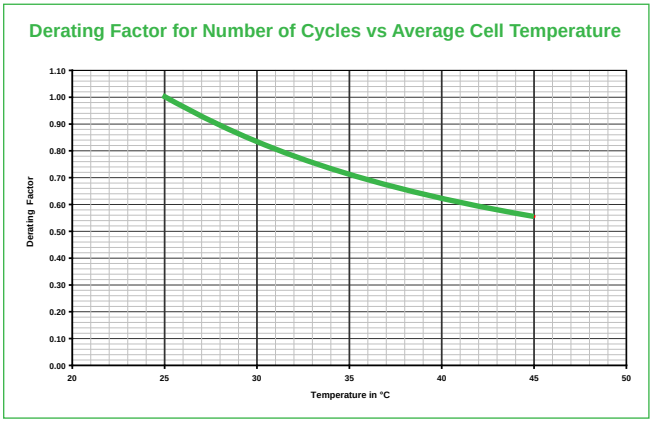
Daily cycle:
The battery is normally used with a daily cycle as follows:
Charge during the day hours and discharge during night hours.
Typically daily use is between 2 to 20% DOD.

1.5. Effect of Temperature

On the capacity:
Correction factors of the capacity according to the temperature are shown in the following curve. If the temperature is different from 25°C, correction factors must be applied to the installation rating in order to secure an optimum service life.



On the number of cycles:
A rise in temperature brings about a decrease in the number of cycles (see below).



1.6. Charge efficiency

The charge efficiency is the ratio between the quantity of Ah delivered during the discharge and the quantity of Ah necessary to restore the initial state of charge.

State of charge (SOC)	Ah Efficiency
90	> 85
75	> 90
<50	> 95

2. General Operating Instructions

2.1. Operating Temperature Range

The maximum operating temperature range for PowerSafe® TS technology is -10°C to +45°C (humidity <90%).

Optimum life and performance are achieved at +25°C.
All technical data relate to the rated temperature of +25°C.

2.2. Storage

Store the battery at a dry, clean and preferably cool and frost-free location. Do not expose the cells to direct sunlight, otherwise defects on container and cover might occur.

Limit values for storage conditions: temperature range of -20°C to +45°C, humidity <90%.

Self-discharge:
It is the capacity loss that results when the battery is left at rest (without charge) for a given period of time.

The self discharge will increase:

- With natural ageing of the cell
- Following faulty use such as excessive over-discharge, bad maintenance, by non-demineralised water topping-up
- Temperature rise

The self-discharge rate of PowerSafe TS batteries with the temperature:

Temperature	25°C	30°C	40°C
Monthly self-discharge rate	3%	4.5%	10%

PowerSafe TS technology has a shelf life of 5 months when stored at 25°C. Higher temperatures increase the rate of self discharge and therefore reduce storage life.

This table gives the **maximum** storage period before refresh, at the given average storage ambient temperature:

Average storage ambient temperature	Maximum storage time
20ºC	6 months
25ºC	5 months
30ºC	4 months
40ºC	2 months

PowerSafe TS batteries must be given a refreshing charge:
a. when maximum storage time is reached, or
b. when the OCV approaches 2.10Volts/cell whichever occurs first (OCV = Open Circuit Voltage, it is the voltage measured (between the terminals) when the cell is disconnected from any circuit (zero current))

If the batteries are supplied moist-charged, the storage time shall not exceed 2 years. For filling see special instructions on filling and commissioning moist-charged batteries.

2.3. Freshening Charge

The refresh charge should be conducted using constant voltage (adjusted to the temperature) eg. 2.23Vpc at 20-25°C with 0.1 C_{10} Amps current limit for a minimum period of 96h.

Alternatively, a refresh charge can be conducted applying a constant voltage of 2.40Vpc for 24-48h maximum.

2.4. Commissioning

Please note that the commissioning of moist-charged PowerSafe TS cells should be carried out in accordance with the instructions published in our dedicated moist-charged manual.

Safety, installation & ventilation

The battery room should be well ventilated in order to remove gases produced during charging.The gases (mixture of oxygen and hydrogen) liberated by the cells when on charge may cause an explosion, and therefore, care must be taken not to produce SPARKS: NAKED LIGHTS must be not allowed, and remember NO SMOKING.

Following precautions must also be taken:

- Do not wear clothing likely to create static electricity (nylon) during maintenance operations
- Do not use a portable apparatus linked to an electric plug

The electrical protective measures and the accommodation and ventilation of the battery installation must be in accordance with the applicable “local” national standards, rules and regulations. Specifically EN 50272-2 and IEC 62485-2:2010 standards apply.

Low ventilation requirement according to EN 50272-2.

The battery should be installed in a clean, dry area.

Avoid placing the battery in a hot place or in front of a window (no direct sunlight). Battery racks are recommended for proper installation. Place the cells on the rack and arrange the positive and the negative terminals for connection according the wiring diagram.

Check that all contact surfaces are clean. Tighten terminal screws, taking care to use the correct torque loading.

Terminal screw	Torque
M10 - female	23 - 25 Nm

Follow the polarity to avoid short circuiting of cell groups. A loose connector can cause trouble in adjusting the system, erratic battery performance, and possible damage to the battery and/or personal injury.

Commissioning
The initial charge is extremely important as it will condition the battery service life. So the battery must be fully recharged to ensure that it is in an optimum state of charge.

Case 1:
Using a constant voltage charger.
Cells here will need to be recharged at a constant voltage of between 2.35 and 2.40 Vpc at 25°C for a minimum of 48h and a maximum of 72h with a current limited to 0.10C_{10}.

Case 2:
With no external source available for recharging.
Connect the battery to the solar panel regulator and leave at rest for 1 to 2 weeks.

For this charge, set the regulator to the following values:

	T°C	Voltage
Low charge-restart voltage	0 to 20°C	2.30V
	20 to 40°C	2.30V
High charge-disconnect voltage	0 to 20°C	2.50V
	20 to 40°C	2.45V

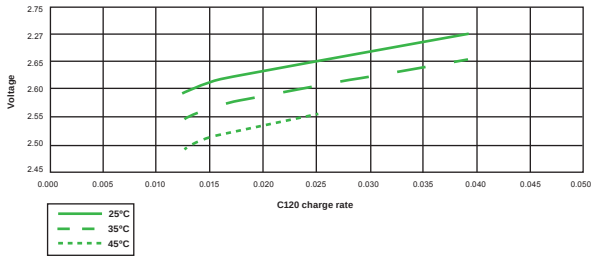
End-of-charge
End-of-charge is when all cell voltages and electrolyte specific gravities (corrected to 25°C) cease to rise for three consecutive hourly readings.

Continue charging until the specific gravity of electrolyte for all cells rise to nominal specific gravity at maximum level.

Cell voltages:

Charging rate (C=Capacity)	Minimum voltage in volts per cell for:			
	15°C	25°C	35°C	45°C
C/20	2.75 V	2.70 V	2.65 V	2.60 V
C/30	2.70 V	2.65 V	2.60 V	2.55 V
C/45	2.67 V	2.62 V	2.57 V	2.52 V
C/60	2.64 V	2.59 V	2.54 V	2.49 V

End-voltage as a Function of Charge Rate and Temperature



Electrolyte specific gravities:

- Measure the specific gravity with a hydrometer
- After reading, squirt the solution back into the cell from which it was drawn
- The nominal specific gravity at the end of the charge at the specified level is for a temperature of 25°C
- If temperature is above or below 25°C, specific gravity reading must be adjusted using the table hereunder.

Specific gravity				
15°C	20°C	25°C	35°C	45°C
1.147	1.144	1.142	1.138	1.131
1.167	1.164	1.162	1.157	1.149
1.186	1.183	1.180	1.176	1.168
1.206	1.203	1.200	1.194	1.187
1.217	1.213	1.210	1.204	1.197
1.227	1.223	1.220	1.214	1.207
1.237	1.233	1.230	1.224	1.216
1.244	1.240	1.237	1.231	1.223
1.248	1.244	1.241	1.234	1.226
1.254	1.250	1.247	1.240	1.232
1.259	1.255	1.252	1.245	1.236
1.270	1.266	1.263	1.256	1.247

Nominal electrolyte specific gravity of PowerSafe® TS cells at maximum level = 1.240 at 25°C
Values according to electrolyte level at 25°C:

Type	Minimum	Medium	Maximum
TLS, TVS & TYS	1.280	1.260	1.240
TZS	1.265	1.250	1.240

2.5. Disposal

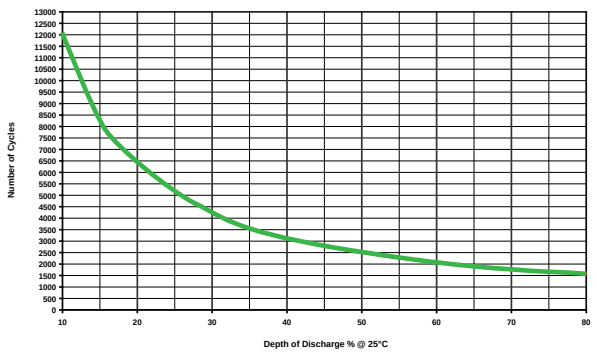
Lead acid PowerSafe TS batteries are recyclable. End of life batteries must be packaged and transported according to prevailing transportation rules and regulations. End of life batteries must be disposed of in compliance with local and national laws by a licensed battery recycler.

3. Cyclic Operation

3.1. Cyclic Performance

The graph below shows cycling capability of Powersafe® TS products (25°C):

Number of Cycles vs Depth of Discharge



3.2. Discharging (low voltage urgent and non-urgent alarm)

As a rule, installations will be equipped with a regulator whose voltage threshold values will protect against deep discharge:

	Discharge time		
	10h	120h	240h
Low voltage alarm	1.92V	1.92V	1.95V
Disconnect voltage	1.80V	1.85V	1.90V

3.3. Setting Charging Voltages (solar charge on and solar charge off voltages)

In order to ensure optimum recharge, the following setting charge disconnect and restart voltages can be applied:

	Temperature			
	-20 to 0°C	0 to 20°C	20 to 35°C	> 35°C
Low recharge-restart voltage (Vpc)	2.35V	2.30V	2.30V	2.25V
High recharge-dis-connect voltage (Vpc)	2.50V	2.45V	2.40V	2.35V

For a battery discharged to 80% of its rated capacity within 120 hours, in optimum sunshine it will take around fifteen days to recharge the cells and a further fifteen days to equalize their specific gravity.

4. Service Life

Under normal operating conditions, the battery lifetime largely depends on the temperature and depths of discharge. The service life in cycling applications based on the number of years with a daily DOD can never exceed the design life at 20°C of 20 years.

Influence of temperature

Example of an Powersafe TS battery cycling with 25% daily:

Average temperature of cells	Number of cycles at 25°C	Compensation coefficient	Estimated average number of cycles at average temperature
25°C	5200	1	5200
30°C	5200	0.83	4316
35°C	5200	0.71	3692

Influence of depth of discharge

See curve (section 3.1), relative to number of cycles according to DOD at 25°C.

Example of an Powersafe TS battery at 25°C:

Daily depth of discharge	Number of cycles at 25°C	Estimated service life at 25°C
25	5200	> 14

5. Maintenance, Checks & Data Recording

5.1. Water Consumption

Flooded batteries require maintenance watering.
Water consumption depends on the charging current at a given temperature.

Example for a battery fully charged with a constant voltage of 2.35Vpc:

	Temperature		
	25°C	35°C	45°C
Charging current mA/Ah	1	4	9
Water consumption ml/Ah/year	2	10	25

Because there is a large electrolyte reserve, water may be added just once a year.

Exact watering frequency will be determined by climate conditions and the battery location.

Top up the electrolyte level (only with demineralised water) to the nominal level, without exceeding the “max” mark.

5.2. Checks & Data Recording

- The containers and lids should be kept dry and free from dust. Cleaning must be undertaken with a damped cotton cloth without additives and without manmade fibres or addition of cleaning agents, never use abrasives or solvents. Avoid electrostatic charging.
- Every 6 months, check total voltage at battery terminals, cell voltages & electrolyte specific gravity (electrolyte level & temperature) of pilot cells, the cells surface temperature and battery room temperature.
- Once a year, take readings of individual cell voltages too.
- Keep a logbook in which the measured values can be noted as well as time and date of each event like commissioning date, water consumption, discharge tests, topping-up dates etc.

Notes

We shall be the best in the industry

by being easy to do business with,

while supplying the highest quality products

and services on time and

in the most cost-effective manner

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