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**BATTERY OPERATION  
GUIDE FOR HYBRID  
APPLICATIONS**

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**EnerSys**<sup>®</sup>

Power/Full Solutions

RESERVE  
POWER

## 1. General Operating Instructions

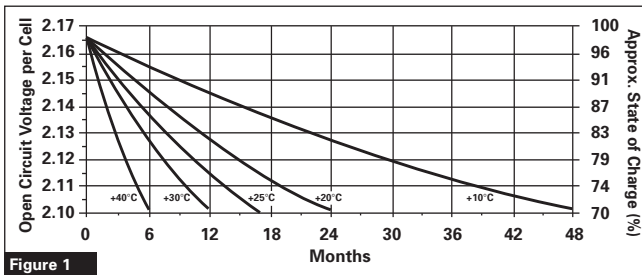
### 1.1 Operating Temperature Range

The recommended operating temperature range for SuperSafe™ SBS EON Technology™ batteries in hybrid applications is -40°C to +50°C. Optimum life and performance are attained at +20°C, however, with the correct controls in place, cyclic performance in hybrid applications is not impacted by elevated temperatures (providing that the maximum battery temperature is not allowed to exceed +50°C).

### 1.2 Storage

SuperSafe SBS EON Technology battery types have a shelf life of 2 years when stored at 20°C. Higher temperatures increase the rate of self discharge and reduce storage life.

Figure 1 gives the relationship between storage time, open circuit voltage (OCV) and state of charge as a function of temperature.



### 1.3 Freshening Charge

SuperSafe SBS EON Technology battery types must be given a freshening charge when the OCV approaches 2.10 Volts/cell or when maximum storage time is reached (whichever occurs first).

The freshening charge should be conducted using constant voltage in the range of 2.29 to 2.40 volts per cell for a period of 24 hours. The charge current should be limited to a value expressed numerically in Amps as 10% of the 10 hour capacity rating of the battery (ie. 19 Amps for SBS 190F).

The maximum storage times between refresh charge and recommended OCV audit frequency is given in the table below.

Temperature (°C / °F)	Storage Time (Months)	OCV Audit Interval (Months)
+10 / +50	48	6
+15 / +59	34	6
+20 / +68	24	4
+25 / +77	17	4
+30 / +86	12	3
+35 / +95	8.5	2
+40 / +104	6	2

### 1.4 Commissioning

Prior to commencement of cyclic duty, the battery must be given a commissioning charge. This shall consist of 24 hours charge at a voltage equivalent to 2.40 Volts/cell with no load connected.

### 1.5 Fast Charging

Fast charge techniques must be used for frequent discharge cyclic applications. In such applications the rectifier output voltage should be set at 2.40 Volts/cell (20°C).

### 1.6 Current Limit

Inherent low internal resistance allows SuperSafe SBS EON Technology battery types to accept in-rush currents up to 600% C<sub>10</sub> amps (e.g. SuperSafe SBS 190F in-rush current up to 1140 Amps). For reliable cyclic performance and to achieve maximum cycle life potential, the acceptable recharge current limit range is 0.1 to 1C<sub>10</sub> Amps (e.g. for SuperSafe SBS 190F the recharge current range is 19 Amps to 190 Amps per series string).

### 1.7 Disposal

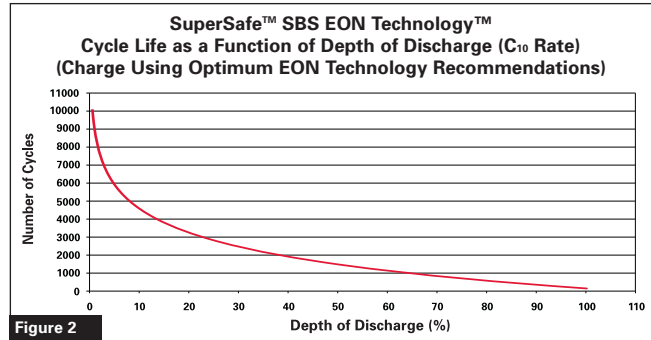
SuperSafe SBS EON Technology batteries are recyclable. End of life batteries must be packaged and transported according to prevailing transportation rules and regulations. End of life batteries must be disposed of in compliance with local and national laws by a licensed battery recycler.

## 2. Cyclic Operation Guidelines

### 2.1 Cyclic Performance

SuperSafe SBS EON Technology has been developed from proven SBS Thin Plate Pure Lead (TPPL) technology, to provide the added capability of delivering higher levels of cyclic performance as illustrated in figure 2.

In order to achieve the cycle life shown in figure 2 SuperSafe SBS EON Technology batteries must be returned to full state of charge using the charge regime options recommended by EnerSys® prior to commencement of the next discharge cycle. Operating at partial state of charge will significantly reduce cycle life.



### 2.2 Discharge

Depth of discharge must be measured using an Ah counting device, with an accuracy ±1% of full range of expected discharge cycle currents. The classification of the shunt should be minimum of 0.2. A low voltage disconnect should be used to protect the battery from abusive deep discharge (typically 1.75 Volts/cell).

### 2.3 Recharge

Optimum cycle life (figure 2) is achieved by controlling the amount of recharge back into the battery to a level where 103% of discharged Ah is returned. Controlled recharge can be achieved by Ah counting using a device capable of measuring float current equivalent to 100mA/100Ah of installed battery capacity.

Alternatively, where Ah counting during recharge is not available, it is possible to calculate the required recharge time based upon the following formula.

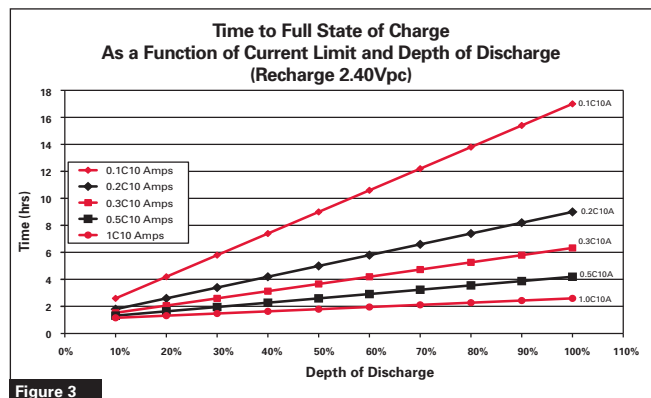
$$\text{Recharge time (hrs)} = \frac{(\text{discharged Ah} \times 0.8)}{\text{recharge current limit}} \times 2 + 1$$

#### Example

SuperSafe SBS 190F discharge to 80% depth of discharge removes 152Ah. With a current limit of 0.5C<sub>10</sub> A (95 Amps), the time to recharge the battery is:

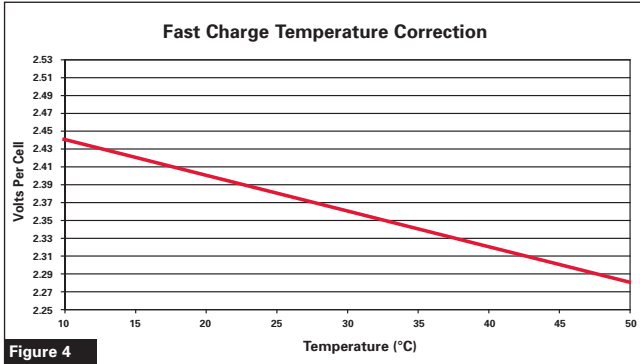
$$\begin{aligned} \text{Time (hrs)} &= \frac{(152 \times 0.8)}{95} \times 2 + 1 \\ &= (121.6/95) \times 2 + 1 \\ &= 1.28 \times 2 + 1 \\ &= 2.56 + 1 \\ &= 3.56 \text{ hrs} \end{aligned}$$

Indication of time to full state of charge using the above formula for various depths of discharge and current limits is shown in figure 3.



The time to reach full state of charge is influenced by battery temperature and charge voltage during the recharge.

- 1) Where Ah counting is used to control the recharge (i.e. 103% of discharged Ah is returned) the battery voltage can be maintained at a constant 2.40 Volts/cell provided that the battery temperature is controlled at or below +50°C discharged Ah returned.
- 2) Where time formula recharge is used, temperature compensation for charge voltage should be applied at the rates shown in figure 4.



Where rectifier voltage cannot be adjusted to values >2.40 Volts/cell to compensate for temperatures below 20°C, the time to full state of charge will be increased. For additional information and guidance on this, please contact your EnerSys® representative.

At the end of controlled recharge the battery can revert to either discharge mode, or where the battery is used to provide mains back up the voltage should be reduced to float voltage level of 2.29 Volts/cell.

#### 2.4 Data Recording

In order for the warranty to be valid, the user must provide, by means of routine regular data logging, the following data:

- 1) The number of cycles performed and the depth of discharge ("dod") of each cycle.
- 2) The duration of each discharge and charge cycle, and the Ah in and out.
- 3) Full details of the recharge voltage/current profile for the last 50 cycles.
- 4) A full history of the ambient and battery surface temperatures, recorded at regular intervals throughout battery operation and life.
- 5) The time and date of each "event" (an "event" is defined as the start /stop of the battery discharge, the start/stop of the battery recharge, the start stop of any generator input power or other input power source, etc).

#### Warning

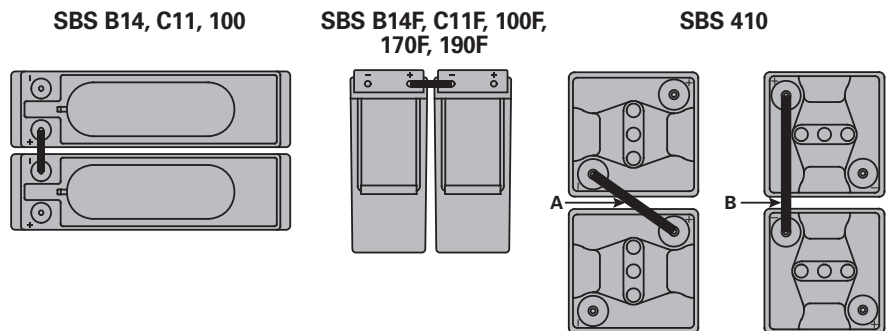
**In hybrid applications it is important that the maximum temperature of the battery in operation does not exceed +50°C. Continuous charge at 2.40volts/cell will significantly reduce the battery life.**

### 3. General Specifications

SuperSafe™ SBS Battery Type	Nominal Capacity (Ah)			Nominal Dimensions								Typical Short Circuit Current (A)	Resistance (mΩ)	Internal Terminals
	Nominal Voltage (V)	to 1.80Vpc @ 20°C	10 hr rate to 1.75Vpc @ 77°F	8 hr rate Length	Width	Height	Weight	Weight	Typical Short Circuit Current (A)	Resistance (mΩ)	Internal Terminals			
SBS B14	12	62	62	280	11.0	97	3.8	264	10.4	19.1	42.0	1800	7.0	M8 F
SBS B14F	12	62	62	303	11.9	97	3.8	264	10.4	19.1	42.0	1800	7.0	M6 M
SBS C11	12	92	91	395	15.6	105	4.1	264	10.4	28.0	61.6	2300	5.5	M8 F
SBS C11F	12	92	91	417	16.4	105	4.1	256	10.1	28.0	61.6	2300	5.5	M6 M
SBS 100	12	100	100	395	15.6	108	4.3	287	11.3	32.6	71.9	2210	5.6	M8 F
SBS 100F	12	100	100	395	15.6	108	4.3	287	11.3	32.6	71.9	2210	5.6	M6 M
SBS 170F	12	170	170	561	22.1	125	4.9	283	11.1	52.5	115.7	3400	4.0	M6 M
SBS 190F	12	190	190	561	22.1	125	4.9	316	12.4	60.0	132.3	3800	3.3	M6 M
SBS 410	2	410	410	200	7.9	208	8.2	239	9.4	23.2	51.1	4725	1.3	M8 M

### 4. Connectors

SuperSafe™ SBS Battery Type	Connector Part No.
SBS B14, C11	2205-8919
SBS B14F, C11F	2205-8891
SBS 100	2205-8750
SBS 100F	2205-8749
SBS 170F & 190F	2205-8769
SBS 410	2205-9887 (A)
SBS 410	2205-8865 (B)





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