Basic battery management

A beginner's guide on how to maximise battery life and electrical system reliability without spending unnecessary cash or time, by Rupert Holmes

A summer cruise is often the point at which it first becomes apparent that a boat's batteries are well past their prime. While a well-looked after battery bank has the potential to last a decade, failure can happen in as little as three seasons if they are repeatedly discharged well below 50% of capacity.

Many newer yachts have excellent battery monitoring and charging systems. However, these are not an automatic panacea, as they must be carefully calibrated, and re-calibrated as the battery bank capacity slowly declines with use. Equally, smaller or older yachts frequently have no effective means of keeping an eye on the state of battery charge.

Leaving things to chance is a big risk, however. At best you might regularly discharge the batteries to the level at which their lifespan quickly diminishes. At worst, you may not have sufficient power to run lights and other critical systems when on passage, or even start the engine if there's no dedicated start battery.

Here are eight easy steps to maximise reliability and avoid the expense of premature battery failure:

1. Monitor system voltage

The voltage produced by a battery, when no load is being drawn from it, is a good guide to its state of charge. When fully charged, a 12V battery can theoretically hold up to 13.2V, although in practice 12.8V or 12.9V is a more likely maximum.

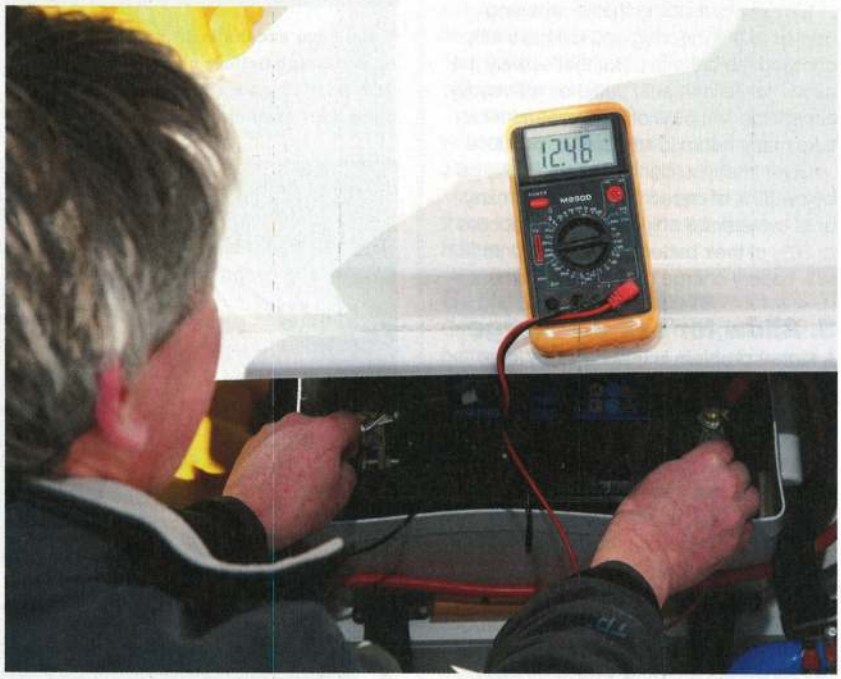
At 12.5V, the battery has 75% of its maximum charge remaining, and at 12.2V there's 50% of the battery's total capacity left. At this stage the battery should be recharged to avoid unnecessarily shortening its lifespan.

If the reading drops to 12.0V, there's only 20% of the battery's capacity remaining, and the battery will in effect be fully discharged at 11.8V. Note that it may take several minutes for any battery to return to a roughly stable voltage after charging, or after drawing a heavy load.

Many boats have an old-school moving needle voltmeter, usually mounted near the main switch panel at the navigation station.

Rupert Holmes

Voltage gives a quick and easy rough guide to the state of charge. This meter is hardwired into the system and held on to the panel with Velcro



Graham Snook

A voltmeter attached direct to the battery terminals gives the most accurate reading

Unfortunately, these are next to useless when assessing battery state – to do this we need to measure the voltage to within 0.1V. The solution is a cheap digital multimeter. These cost as little as £5, and can be hardwired into the boat's system and attached to a convenient spot with adhesive-backed Velcro.

Purists might argue that this arrangement has drawbacks – to get an accurate measure of battery charge the voltage should be measured directly at the battery terminals. And then only once the batteries have been allowed to rest for several hours.

However, what you really need to know is when to charge them while on passage – and that's easy – it's when the system voltage drops to 12.2V.

There's one other factor to be aware of – simply measuring static voltages makes it possible to confuse a battery that's almost at the end of its life with one that is simply flat and needs charging. The old battery may give reasonable voltage readings after charging – as high as 12.7V or 12.8V, but these will fall considerably when even a small load is drawn.

Battery types

Automotive batteries supply very high loads to starter motors for a few seconds but aren't suitable for systems that draw small amounts of power for many hours. Leisure batteries have thicker plates and are better for slow discharges to a lower percentage of their capacity. Traction batteries that have extra thick plates, and therefore weigh more, can withstand 1,000 charge-discharge cycles.

AGM and gel batteries cannot spill battery acid and will provide more charge-discharge cycles than conventional deep discharge batteries. AGMs are capable of being used for both starting and deep cycling and accept charge more readily.

Lithium-ion batteries are extremely robust and, although still expensive, their price is falling all the time.

2. Start with fully charged batteries

This sounds obvious, but it's surprising how difficult it can be to achieve.

Boats that live alongside with access to shore power can use a three- or four-stage battery charger to keep the banks topped up. However, this is much harder for a boat that's kept on a mooring with no access to mains electricity.

It's easy to assume that in motoring upriver to the mooring you will have fully charged the batteries. But that's rarely the case – while lead acid batteries will readily accept the first 80% of their charge, it can take many hours to top up the final 20%.

Given that you don't want to discharge below 50% of capacity that means many boat owners are only ever getting access to 30% of their battery capacity. Worse still, battery charge declines over time…

Rupert Holmes

If you have access to shorepower a three- or four-stage battery charger will ensure your boat's batteries are always topped up to their maximum

Rupert Holmes

Even a small solar panel like this 10W one will protect a battery against self discharge and doesn't need to be connected to a regulator

3. Allow for self discharge

A further problem is that batteries lose charge while standing idle.

The rate at which they do so varies with temperature and with different types of battery, but 5% per month is a good rule of thumb to work on. It stands to reason, then, that if you have a period in which you don't use the boat for several months a significant amount of charge will be lost.

4. Add a solar panel

A simple solution to the problem of battery self-discharge on boats that don't have access to shorepower is the installation of a small solar panel. There's a rough rule of thumb that says that a panel with an output in watts of less than 10% of the battery's amp-hour capacity doesn't need to have a regulator (it'll never be able to pump in enough charge to damage the battery) which makes it an option that may cost as little as £10.

Rupert Holmes

A larger solar panel – this one is 100W – will provide a useful proportion of daily needs and will ensure batteries are full at the start of each trip

'A simple solution to the problem of battery self discharge is installation of a solar panel'

In practice in good summer weather, as well as replacing battery losses through self discharge a small panel will also slowly charge the batteries above the 80% mark. If you return to the boat after a fortnight you might be lucky enough find they have more than 90% charge.

A perhaps more viable alternative is a larger panel that charges via a regulator to prevent the batteries becoming overcharged. This will mean you can be sure of well charged batteries at the start of each weekend, as well as supplying at least a proportion of your needs for each day spent on board.

Much has been written about where to position solar panels for maximum efficiency, with the conclusion inevitably being to erect an arch at the back of the boat. While there's some merit in doing so, it misses the point that, for a great many boat owners, a 60-100W solar panel will make an enormous difference, almost irrespective of where that panel is located.

Both my boats therefore have solar panels on the coachroof, under the boom.

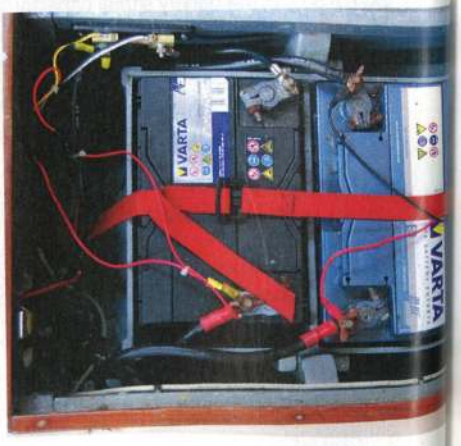
In Greece it's a 60W panel that provides enough power to run lights and power my laptop for a day's work, even in March.

In the UK it's a 100W panel that's similarly effective and every time we return to the boat after a break of a few days the 220Ah battery bank is at 100% charge.

5. Reduce loads

Reducing the amount of power you drain from batteries will also help prolong their life. That's becoming significantly easier in an era in which LED interior light bulbs are cheap and tablets or phones are frequently used for tasks that would previously have required a laptop.

LED bulbs are not always a good direct replacement for incandescent or halogen bulbs in navigation lights as a single point light source is needed to ensure the colour sectors are correct. If funds are limited fitting an LED tricolour will minimise power drain while sailing. If the lower-level lights remain halogen, but are used only when motoring, it doesn't matter if they are not optimised for low power consumption.



Yachts should have at least two batteries – one for engine starting and one for running the boat's electrical systems

Graham Snook

Simply improving fridge insulation can reduce power consumption on board

A properly calibrated battery monitor can give a wealth of information on battery state and energy use

Simple 1-both-2 switch is an efficient way of using and charging batteries – but you have to remember to switch it manually

On many boats the fridge is a huge consumer of energy. On a recent Atlantic crossing we calculated our modest 45-litre unit was the single most power-hungry item on the boat, consuming more than 70Ah per day – more even than the autopilot. In the past most boatbuilders did a very poor job when it came to the insulation of built-in fridges, so improving this will pay big dividends.

6. Upgrade older split charging systems

To prevent a battery used for starting the engine becoming severely discharged it's good practice to have separate battery banks for engine starting and for domestic/service loads. However, this then creates a problem as how to charge two separate banks from a single engine-mounted alternator.

Historically, many boats were fitted with a pair of hefty diodes to create a 'fit and forget' system that would automatically keep the two banks separate, while enabling the alternator to charge both simultaneously. It's a relatively cheap and simple system, but the drawback is a voltage drop of around 0.7V over the diodes, which significantly reduces the rate of charge that reaches the batteries.

On my boat in Greece, after a couple of years of ownership and frustration of the slow charging thanks to this voltage drop, I changed to a 1-both-2 switch. This replaces the automatic system with manual switching – you select battery 1 to start the engine, batteries 1 and 2 for charging while the engine is running, and battery 2 alone when the engine is turned off.

At the time it was a quick, simple and effective way to boost the charge into the batteries – providing I always remembered to switch manually.

Technology changes though, and 15 years on if I was to do the same again I'd simply replace the diodes with voltage sensitive relays. These are set to switch automatically at different voltages, replicating the functions of my manual system in a fool-proof manner.

7. Fit a smart alternator regulator

Traditionally yachts were fitted with automotive-style alternators, which are intended to cope with the electrical load when the vehicle is in use, as well as replenishing any charge used in starting the engine.

The trouble is, the way in which we use our boats is very different to the way cars are used – there's still significant power drain when the engine is turned off.

In any case, even if you're motoring for several hours in a calm, the charge rate drops rapidly after the first 30 minutes or so of charging with a standard alternator. This is why it's hard to put the final 20% of charge into a battery bank when charging.

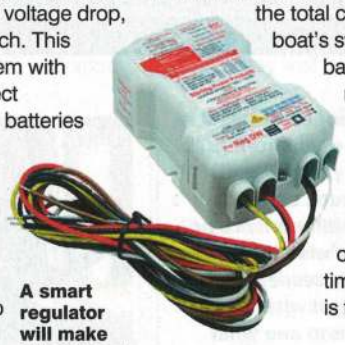
A smart regulator is the answer here – it will maintain a high charge rate from an alternator for much longer, offering the same charging profile as sophisticated three- or four-stage mains-powered battery chargers.

8. Battery monitors

Critics will point out that relying solely on battery voltage to assess state of charge/discharge in real-world conditions is misleading, as it takes a long time – potentially several hours – for voltages to stabilise after charging or drawing a load, although they will approximate to the final figure in only a few minutes.

The solution to this is a properly configured and calibrated battery monitor. Properly set up, battery monitors are superb and there are good reasons people pay good money for them, but they are not essential and many are set up such that they give misleading data.

The idea of battery monitors is to give a precise indication of how much charge there is left in the batteries. This accounts for all factors that affect battery state, including calculating the total charge delivered to the batteries, and subtracting the total charge used by the boat's systems. In addition to battery voltage, these monitors can display battery charge/discharge current; state of charge of the battery in amp-hours (Ah) or in percentage of total capacity; and time to go until the battery is flat.



A smart regulator will make the most of charging batteries from the engine's alternator

While battery monitors are capable of giving excellent useful data, they need to be carefully set up, in particular when determining the capacity of each battery bank.

Even with new batteries this is not easy, as different manufacturers quote slightly different figures and the nominal figures given could vary between different batteries of the same specification.

A further problem is that battery capacity declines over time, with the trend accelerating as the bank nears the end of its useful life. PBO