SOMETIMES WE HANDLE ENQUIRIES WITH REGARDS TO LEAD-ACID STORAGE BATTERIES (EG SB1800) FAILING "PREMATURELY".

In virtually every case we have investigated, it wasn't the battery failing, though the expectation of the user and the natural limitations of the batteries, expecting their "off-grid" setup to work like a grid-connected power point.

The simple reality is that any type of rechargeable battery only has a limited number of charge/discharge cycles, much as the average family car only has a realistic lifespan of somewhere around 300,000km.

Take for example the Jaycar SB1800:

This consists of 6 x 2 Volt, 600 Amp/hour cells, connected in series to give a 12V 600 Ah battery pack.

These are the specifications relevant to lifetime:

• Cycle life:

1000 cycles at 100% discharge
1200 cycles at 80% discharge
2000 cycles at 50% discharge
4000 cycles at 20% discharge

• Self-discharge: Less than 1% per week

• Design life: 20 years

So what does all this mean? Well, 600 Amp Hours is straightforward enough. It means you could draw 1 amp for 600 hours before the battery reached its cut-off point of 10 Volts. Or you could draw 2 Amps for 300 hours, 4 Amps for 150 hours and so on.

100 Amps for 6 hours even? Well, not exactly. The more amps you pull from the battery, the faster its terminal voltage drops, due to a phenomenon called "internal resistance". It depends on the battery, but you might only be able to draw 100 Amps for say 4 hours before the terminal voltage drops to less than 10V and your appliance's low-voltage shutoff kicks in.

However, as soon as the appliance disconnects, the voltage might jump back into the "safe" region of 11 Volts or so. You'd actually find that the remaining 200 Amp hours are still mostly there, but they can only be extracted by discharging for a longer time with less current. So if you have a light that draws say, half an Amp, you might be able to get nearly 400 hours' further operation from that. But try to draw any heavy current from it and the device will probably shut down.

*NB: This assumes that your appliance does actually have such a cut-off system, otherwise the battery can run completely flat, which can **drastically** shorten its lifespan!*

Now we come to "Cycle Life" part. That should be pretty straightforward too:

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A "100% discharge" is when you fully charge the battery, and then run it right down to its cut-off point. (Analogous to completely filling your car's petrol tank and only refilling it when it's almost empty).
So, with the SB1800, you can do that approximately 1,000 times, right?

Well, sort of. Every charge/discharge cycle shaves a little bit off the capacity of the cell. It's analogous to the way the engine wear from every kilometre you drive your car reduces its fuel economy by a miniscule amount. After a large number of kilometres, all those miniscule amounts start to add up and your car's fuel economy and general performance tend to deteriorate. There is no specific point where the car becomes unusable; it's more a matter of how much degradation you are prepared to tolerate.
In the case of the battery, by the time you've clocked up your 1,000th charge discharge cycle you might be only getting 400 Amp/hours or less (again, this is heavily dependent on the particular type of battery).
If you only ever discharge it by 20% of its capacity, then you can expect 4,000 cycles. If you're using it in a solar powered installation where it gets charged up during the day and run down by 20% every night, then that will happen 365 times a year so that's about 4,000 ÷ 365 or about 11 years. But again, that's actually 11 years until the battery drops to about 70-80% capacity.

There are more complications. Notice that reducing the average discharge from 100% to 20% doesn't give a five-fold increase in lifespan; it's actually only four-fold.
OK, so what you get for your 20% discharge? *Not anywhere near as much as many people seem to think*, and that's a large part of the problem! Most installations use at least 2 x SB1800 connected in series to give 24 Volts. 20% of 600 Amp hours is 120 amp hours, and with a 24 Volt setup, that theoretically means you could run 24 x 120 = 2,880 Watts worth of appliances.
That sounds reasonable doesn't it?

Not so fast! That's 2,880 Watts for just *one hour!* In most locations useful solar power is only generated between the hours of 9AM and 3PM, so there's another 18 hours that the battery is going to have to provide the power for. 2,880 ÷ 18 = 160 Watts! A modern medium-sized fridge typically draws an average of around 100 Watts, depending on the climate and where it's situated. If you get a sensibly-sized fridge with the highest energy star rating you can find, and keep it in a well-sheltered location away from direct sunlight, you might be able to squeeze it down to 80 Watts leaving you with another 80 Watts to play with.
80 Watts might not sound like much, but it would be enough for running energy-efficient LED lights, since they're not normally used all the time.
Similarly, you can run LCD TV (less than 32") if you pick one with a good energy star rating, plus maybe a DVD player and PVR, again on the assumption that they're not being run 24/7.

Phone and laptop chargers would also be OK, but not a complete desktop PC. Microwave ovens would also be OK but you'd need to always switch them off at the wall when not in use. (The ideal solution would be an old-fashioned one with a mechanical timer switch, since when they're "off" they're completely "off", but nobody seems to make those any more).

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After that, you would need to seriously consider getting 4 x SB1800 to give a 24V 1200 Amp/Hr system.

So what happens if you get a run of days of cloudy weather and the solar panels aren't charging? What you're *supposed* to do is have a setup that detects when the cells have fallen to about 80% of full charge and either alert you about this or automatically start up your standby generator. However, if solar "outages" are fairly rare where you live, and you have a big enough solar array, it is permissible to *occasionally* let the charge drop down to as low as 25%, *but no further.* As long as the panels can get the full charge back up in a couple of days, no real harm will be done by this. But if this is going to be a fairly regular occurrence, a backup generator is mandatory.

But sadly, for many installations all this seems to go pretty much in one ear and out the other! The first thing a professional installer would do is conduct an "energy audit," basically working out what the average daily power consumption is going to be and designing a battery system with at least four times that capacity, and a solar array that can deliver sufficient power to replace that consumed power on the shortest and coldest day of the year.

What most people fail to understand is that the power level specified in the original audit is *all you can ever have.* You can't for example:

- Add another fridge or freezer, (or upsize *unless* it has identical or less power consumption)
- Add a bedroom TV or upsize your existing one
- Use any A-V appliances that consume standby power
- Install a pool pump(!)
- Use high power kitchen heating appliances *including:*
  - ►Cappuccino machines
  - ►Electric Kettles
  - ►Waffle Irons
  - ►Electric Frypans
  - ►Deep fryers
  - ►Toasters
  - ►Benchtop Ovens
  - ►Electric hotplates
- And *under no circumstances* can you use:
  - ►Electric Heaters
  - ►Electric Blankets
  - ►Clothes Dryers

But all of the above (and more!) are routinely found when investigating claims of "premature" battery failure.

What generally happens is that, instead of starting up the generator (If Installed) as soon as the battery capacity falls below 80%, people wait until the lights start to go out before starting it. The result is that the battery bank is run virtually flat every day, which gives about 3 years maximum lifespan.

A big problem with plugging high-power devices into the system is that they will actually work with no apparent harm to the system. The "harm" only becomes apparent when they only give 3 years instead of 11 years battery life!

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Cell Polarity Reversal

Another consequence of over-discharge is that no two lead-acid cells have exactly the same capacity, and where you have 6 (or 12) of these connected in series to make a 12V or 24V battery, if you discharge the battery completely, one or more of the cells are going to go completely flat before the others, with the result that they get charged in the reverse direction while the other are still discharging. This drastically shortens the life of those cells and is a major cause of battery failure. Two or more such failures in a battery pack are considered *de facto* evidence of over-discharging.

"Design Life"

This is one of the most misused device parameters
This is simply the manufacturer's estimation of the maximum possible useable lifetime of the battery. In the case of the SB1800 it's 20 years.
But what does that mean exactly?
The answer might seem a little strange: 20 years is the maximum length of time they guarantee the capacity will not drop below a certain level (typically 60%) if the battery is kept charged but *not actually used*.
This is not as silly as it might sound. One major application for batteries like these is providing standby power for power-critical installations such as mines and hospitals. The setup there is very similar to an Uninterruptible Power Supply (UPS) used with computers: When AC power is available, this is routed directly to the 240 Volt outlet socket, while an internal charger keeps the internal battery charged up.
If the mains power goes off, the AC output switches over to an inverter powered by the same battery.
Most computer UPS's are only intended to run the computer and its monitor for long enough to save any work and close the computer down properly. In a safety-critical application such as mining or hospitals, the system is mainly present to give the main standby generator time to start up, and if necessary, allow time for any operational faults to be corrected (fouled spark plugs etc). *It is perfectly feasible for such a battery to go through its entire service life, never having been discharged, except for occasional mandatory testing of the system.*
But, even of it is never discharged, there is still a definite lifetime limit for batteries.

You could compare this with the lifespan of average car. Most family sedans have an operational life of around 300,000 km. After that the engine and gearbox start to deteriorate and their gaskets begin leaking oil. So what is that in years? Well, if you drove around 30,000km per year, 10 years would not be an unreasonable estimate for the expected lifespan. If you only did about 15,000lm per year, 20 years would also be a reasonable figure.

But that doesn't mean that if you drove it only 3,000km per year, it's going to last 100 years! 30 years is the absolute limit before you would need a complete re-build. Car manufacturers work on the assumption that most of their products are going to be scrapped after 20 years or less, so they don't want to waste money on building in quality that is not going to be of any practical use.
So after about 20 years, the engine and gearbox start leaking oil, the rubber suspension components start to fall apart, the upholstery starts to deteriorate and so on.

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The Bottom Line
is that a large lead-acid battery pack is really only capable of reliably delivering a small fraction of the power people imagine it can.
It will allow you to run devices that can *only* be run from electricity; *everything else should either burn gas, kerosene or firewood.*
As far as the high powered appliances are concerned, if you want to use any of those, you need a large generator.

As far as warranty claims go, a five cent component failing in your large screen TV or your car's engine management system can stop them working instantly. But those are extremely complex devices containing thousands of components.

A lead-acid cell basically consists of two large plates of spongy lead sitting in a bath of sulphuric acid. Premature failures are nearly always caused by improper use of the battery…..

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