Electrical Needs Aboard AKAMA

A motor yacht, even one as small as AKAMA, is not much different from a house or an apartment. We have all the AC lights, appliances and toys that we had when we lived ashore, including the big electricity consumers such as the dishwasher, water heater, clothes washer/dryer and air conditioners. AKAMA also has lots of equipment that runs on 12-Volts DC, including emergency lighting, fans and all the ship's navigation and communication equipment. When we are in a marina, hooked up to "shore power" supplying electricity to all this is usually not a concern; the AC items run off the shore power and the DC equipment runs off a battery, which is kept topped up by a charger. This charger will take any AC input from 90 to 270 Volts at 45 to 70 Hertz and convert that input to 50-Amperes at 12-Volts. We can plug it into nearly any AC socket in the world and get enough electricity to run the essential items on the boat. Once away from the dock, however, we must make and store all of our own electricity. In addition, we must supply our own fresh water, which we do by running a water maker (desalinator), another big consumer of electricity. A description of the water maker can be found in our special report on water needs.

We have a generator that can produce up to 16.5 kW of electricity at 50-Hertz. This is a separate 40 HP diesel engine coupled to a large AC alternator. We generate enough electricity to power simultaneously everything aboard. So, when the generator set is running, life is more or less the same as it is when we are hooked to shore power in a marina.

However, generator sets are a bit noisy and smelly, which puts them at odds with the tranquillity and fresh air while anchored in a secluded lagoon, especially at night. So, AKAMA has an alternate source of energy, our house battery bank. This comprises twelve golf cart batteries in series-parallel, which provides about 12 kilowatt-hours (kWh) of capacity (i.e., 1000 Ampere-hours at 12-Volts). This battery bank runs the DC appliances directly. To get the electricity out of the batteries for the household appliances, we have a black box called an inverter. The inverter takes the 12-volts DC and converts it to 50-Hertz, 230-Volts AC, at about 95% efficiency. However, the inverter can only supply up to about 2.5 kW; so we cannot use it to run the big electricity consumers, which is no big deal. When at sea we don't generally need air conditioning and we'd rather be sightseeing or snorkelling than doing laundry!

When running on the batteries we try to conserve energy by turning off AC circuits that are not needed. For example, the TV, VCR and stereo use quite a bit of electricity when in standby mode; ditto for computer, printers and scanner. At night the only household circuit active is the one for the fridge and the freezer. However, at night we usually also run our anchor light, and our GPS, depth sounder and sometimes the RADAR in alarm mode; these all run directly off of 12-Volts DC from the house bank. On the average we consume about 8.6 kilowatt-hours (kWh) of electricity every 24-hour day. With a stored supply of 12 kWh and a daily demand of 8.6 kWh, one can readily see that we have enough electricity to last about 33-hours. In practice it's just about 24-hour's worth, because totally discharging the house bank is hard on the batteries.

Of course, what comes out must be put back in, or we will end up with dead batteries. The rule of thumb is that for every ampere hour you take out of the battery you have to put back 1.2 ampere hours, due to inefficiencies of the charging process. Also, once the battery bank is about two thirds charged, it is no longer possible to push a heavy charge current into it without damaging the batteries. It is all quite complex and scientific, but we eliminate all the calculations using a special meter that displays Volts, Amperes and Ampere-hours consumed. It also gives us a rough estimate of how many hours we can continue to run until the battery bank is depleted. It is a lot like the fuel computer on some of the up-market cars, except this one is for electricity. We have two ways to recharge the batteries, the alternator on the main engine and battery charger.

Since the alternator is on the main engine, it charges the house battery only when we are moving. It is similar to those on cars and trucks, except that ours is bigger and has a special regulator that enables it to produce more power. It can deliver up to 1.2 kW when the engine is run at full speed (about 2800 RPM), something we never do. At our cruising speed of six or seven knots the alternator produces about 3/4 of a kilowatt (65-Amperes at 12-Volts). Our household needs average about 1/3 of a kW; but, when we are cruising, especially at night, we must also run a lot of other equipment (e.g., GPS, Autopilot, RADAR, and navigation lights). The alternator keeps up with this demand, with about 300 Watts (25-Amperes) left over for battery charging.

The battery charger is the second means of charging, and it requires running the generator set. There are actually two chargers. One is the 50-Ampere charger referred to at the beginning of this article. The other, in the inverter, is a 100-Ampere charger (actually, it is the inverter running backwards). These two chargers running in parallel give us a total charging capacity of about 1.8 kW (150-Amperes). This is enough capacity to bring the house battery from nearly discharged to nearly charged in about 6-hours. In practice, since we never fully deplete the battery and since our electrical needs are being supplied from the generator during the time charging is going on, we need to charge for about 4-hours a day when not on shore power and not moving.

Coming back to the water maker, we consume about 250 litres of fresh water a day, which we make with our water maker. It makes about 90 litres an hour, so it must be run an average of about 3 hours each day to keep up with the demand. As we have a storage capacity of 1900 litres, we can schedule this whenever we wish. In other words, we have engineered the system so that the amount of time needed to replenish the water is nearly the same as the time needed to recharge the batteries. In practice, if we run the generator set for any reason, we always run the chargers and almost always run the water maker.

So, how does it all work? Well, at the dock, the shore power runs everything and the charger keeps the batteries topped up. All the circuit breakers are switched on, just like in a house. Better than in a house, should the shore power fail, the inverter will kick in automatically and keep all of the essential things running; when the power is restored the two chargers will quickly bring the house battery back to full charge. When we leave on a cruise the big appliances are shut down and the alternator keeps up with the demand; so the batteries remain fully charged. Once we arrive somewhere, we usually shut off the engine and any unnecessary AC circuits, leaving the house bank to run the refrigeration and a few other essential things via the inverter. If we are just stopping overnight and then are moving on, we don't need to do anything, as the alternator will just about bring the batteries up during a full day's run. However, if we are staying in one place or only moving short distances, then we must run the generator. Generally, we try to run it while we are going somewhere, as the noise is less noticeable. Also, if we want to run an air conditioner, one or more of the big appliances we must run the generator set; this can be fairly frequent. For example, we often start it while making meals. This saves loading the batteries with the microwave oven, electric kettle and so on.

We could slightly alter the system if we were starting from scratch. The first thing we'd look at is load. Most of the drain is from the refrigerator and the chest freezer, both standard household models. Neither is very energy efficient, especially the freezer. If we re-engineer the system, we'd probably keep the standard household refrigerator, but the freezer would be changed to a custom-built, heavily insulated model. We estimate that we could save as much as 1.20 kWh (100 Ah) per day. This is two-thirds of an hour of generator running time.

Secondly, we increase the amount of battery charging capacity to 300 amperes. When the batteries are really low, one can safely push two times as much into them as our two-charger, 150-Ampere combination does. The rule of thumb is 20 to 25 Amperes of charge current for every 100 Ah of battery capacity. The amount varies depending on whose book you are reading and at very high rates it is advisable to have a temperature sensor on the batteries, hooked to the regulator, so that overheating does not occur. With about 1000 Ah of house bank we could double our charging rate if we fitted a temperature sensor. Of course, this only works when the batteries are really discharged, and as they come up to charge they would not be able to use all this charging capacity. We sometimes do this by running the main engine and the generator at the same time, which pushes about 180-Amperes into the battery. We could save an hour of generator time by doing this.

If we did not make all of our water with the desalinator, then we could reduce the amount of generator set running commensurately. AKAMA is ideally set up to catch rain water from the monkey island, as she has two scuppers that could easily be plumbed to the water tanks. Since our water is all double filtered before it goes to the taps, there would be no problem in doing this. If we could catch even a fifth of our water needs we would save nearly 3/4 of an hour of generator time a day.

Taken together, the above ideas for improvement would reduce the need to run the generator set to only about two hours a day. In any case, we are not out here to do boat maintenance and refit in exotic places; there is enough maintenance to do as it is! As we write this, we are at anchor in Teluk Bay on the west coast of Tioman Island (Malaysia), watching the sun set, G&T in hand. We've been away from shore power for a month. The generator set is running...life is good.

Note AKAMA is set for the world standard voltage and frequency; at least roughly, as there is no true standard. Her AC supply is set up for 230 volts at 50-Hertz. This works nearly everywhere except for North America, where the standard is 240/120-volts at 60-Hertz.