CPAP at Pennsic (v3.12 - 2018)

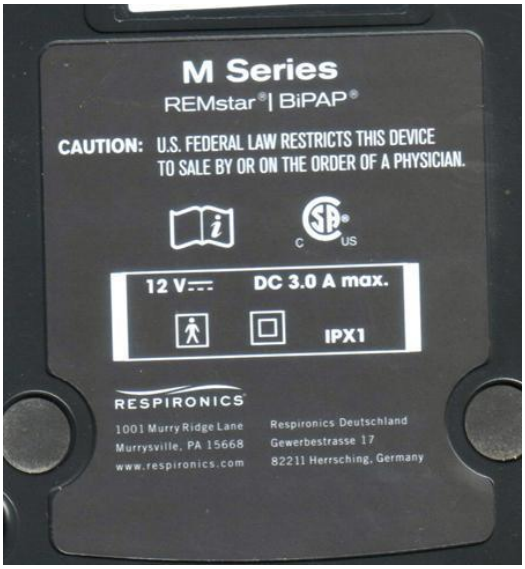
By Master Phillip the Pilgrim, O.P.

What follows is a quick-and-dirty discussion of what it takes to use a CPAP or other medical electric equipment at Pennsic or other camping event that doesn't have easy access to electric power, based on my 14+ years of living with a CPAP machine and 25+ years as a ham radio operator. We'll start off by talking about the good old stand-by: a separate battery. We will then move into more advanced possibilities that weren't available until the past few years.

Getting Started

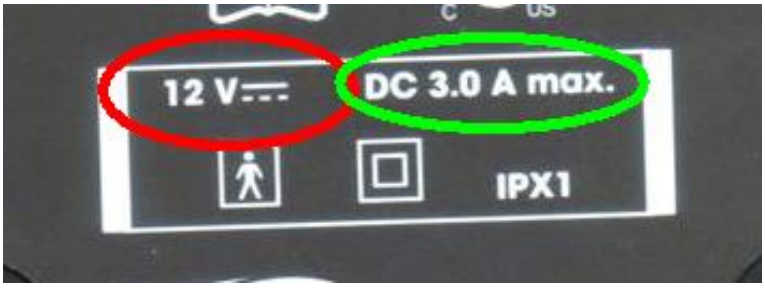
You have some options, depending on your machine and your budget. What you can use depends to a certain extent on what your machine needs, so we need to take a look at your machine.

Somewhere on your CPAP machine is a label. Here's a typical example:



Note: we're looking at the machine itself, not any external power brick. The idea here is to replace the power brick with something else. After all, the power brick is converting wall power (120 VAC) to the power the CPAP needs, and we probably can't plug in to wall power in the middle of a field. (See the section on "**Extension Cords**" below.)

We're looking for a couple of bits of information from the label: the input voltage and the current requirements. The voltage information (circled in red) looks like this:



The part of the symbol with the solid line above the dashed line is the international symbol for DC voltage.

If your machine runs on 12 VDC, then the regular battery option is very straightforward. If you have something else, like 19 or 24 volts, or your machine requires 120 VAC (wall power) directly into the machine, we will need additional equipment. Keep reading.

The current specification (circled in green – "A" is shorthand for **amps**) tells us how much capacity we need to provide. I'll discuss that calculation further down. (In case you are interested, power is defined as *volts*×*amps* and the resulting number is valued in *watts*.)

Battery (12 VDC)

You need a *minimum* of three things to run your CPAP on a battery at Pennsic:

1) Battery
2) Battery Charger
3) Power cables to get battery power to your machine

The battery people usually get is a **lead-acid battery**, similar to what's in your car. Due to the way lead-acid batteries work internally, you'll want a 12 volt **deep cycle** battery (also sometimes called a **marine** battery), or a Sealed Lead Acid (SLA) battery. You can get marine batteries at nearly any auto parts store. You could use a regular car battery in a pinch. However, you will ***ruin*** a car battery in short order (20-40 use/charge cycles). That's because car batteries are designed to provide short bursts of extremely high current, which is what the car's starter needs. Deep-cycle batteries are designed for long, slow, low-current applications, which is a perfect fit for powering smaller devices such as your CPAP. (Note: while we call them "12 volt batteries," lead-acid battery chemistry actually gives closer to 12.8-13.2 volts at full charge.)

Battery Size / Capacity

Battery capacities, and your power needs, are measured in **amp-hours**. This is, as you might expect, the number of amps your device draws multiplied by the hours you run it. Equipment running on a 12 volt battery that draws 3 amps for 8 hours would use 24 amp-hours (3×8). Note that the "A" value on the label is a *peak* value. Your equipment will draw no more than that many amps max. It will probably draw less. The label on my CPAP says 6.67 amps, but that includes a humidifier and heated hose. When I run just the CPAP by itself, it draws 2.1 amps in short bursts (measured with a special power meter), but it averages under half that. I find I use about 3 to 6 amp-hours per night. Other equipment will have different power requirements. Use the equipment's label as a starting point.

You should plan on a battery that has a capacity of at least 3 times the amount you're going to use overnight. More would be better. Repeatedly drawing the full charge out of a battery wears it out faster. I currently use a 50 amp-hour battery (50Ah), recharging it every other day (or continuously via solar) at Pennsic. My previous battery was 80 amp-hours, and I could get along with a recharge once every four days.

Battery Types

Typical marine batteries still have the caps where you put in water. That means you should be checking the water level every few days and topping off with distilled water if the tops of the plates are out of the water. You can also get sealed lead-acid (SLA) batteries, though you might have to go to a specialty battery store or Amazon. Sealed batteries need a slightly different charging plan, discussed below. There's also another kind of sealed battery called Absorbed Glass Mat (AGM), named for the construction of some of the internal components. AGM batteries can take more electrical abuse than most others, but they cost 2-3 times as much.

This is the SLA battery I currently use:

http://a.co/ditRCu1

My previous battery was a marine Diehard battery from Sears.

These batteries still use lead plates inside, so expect them to be heavy.

Battery Charger

There are lots of battery chargers out there for lead-acid batteries. The better ones analyze the battery while charging, to prevent overcharging. This is the charger I currently use:

http://a.co/69GwZmJ

If you're using an older charger that doesn't understand SLA batteries, you should run the charger on the lowest setting. If you get an AGM battery, look for a charger that has an AGM mode. Other battery technologies (such as LiFePO4, also called LFP, discussed later) have specialized charging requirements, so be sure you get an appropriate charger. (See further down about charging batteries at Pennsic.)

Power Cables

Most CPAP 12 volt power cables plug into the CPAP on one end and have something that plugs into a cigarette lighter socket on the other end. The particular cable you need will vary with the brand of CPAP machine you have. You should be able to obtain the appropriate cable from your CPAP supplier, or here:

http://www.cpap.com/cpap-battery-power/cpap-dc-cables.php

I've dealt with CPAP.COM in the past. They are quick and reliable.

You'll need something that has a cigarette lighter socket on one end and clamps that attach to your battery on the other end. They look like this:

http://a.co/6iFqXOH

Radio Shack, if you still have one available, carries a similar item. You can also find battery cases that have built-in cigarette sockets and handles. These are typically found at sporting goods stores near the fishing equipment.

Nice to Have

You will find it useful to monitor the charge of your battery, to see how much capacity you've used. Fortunately, with lead-acid batteries, the capacity remaining is directly related to the voltage when the battery is not under load (not powering anything). An inexpensive volt meter will quickly tell you how close you are to needing a recharge. Fully-capable voltmeters can be found for under $20 – I've seen them at Harbor Freight and on Amazon for $10 or less. The one pictured here works really well and you can also use it in your car:

http://a.co/27iarDr

A fully charged lead-acid battery with no load will read somewhere in the 12.8v range or higher. A lead-acid battery is considered completely discharged when the meter reads 10.5 volts. Pulling more energy out of a fully-discharged lead acid battery will cause internal damage, eventually destroying the battery's ability to hold a charge. I start thinking about recharging when I hit 11.5 volts.

A battery case can be handy as well. Some have the cig lighter adapter built in, and more expensive ones also have a voltmeter built in as well.

Cost

You should expect to pay $100-$200 for all the equipment we've discussed here. It's unlikely to be covered by your health insurance (since it's not provided by a medical equipment company), but it never hurts to ask.

Battery Kits

CPAP vendors now have battery kits available. This is a battery and associated equipment, usually in a nice carrying case. A typical battery kit will run a typical CPAP machine for 8 hours or so, and then need to be recharged (via wall power) the next day. They use lithium-ion or lithium-polymer batteries, the same as your phone or laptop. That means they are pretty light and easy to handle. They will also have the appropriate connectors, so you've got one less thing to worry about. However, they will run you between $200-$500. If you're working with health insurance to pay for your CPAP machine, battery kits *may* be covered.

Car Starter Battery Packs

You can get a self-contained unit that has a case containing a battery, often a cig lighter adapter and jumper cables, and sometimes a built-in charger (and a handle!). These are sold for emergency recharging of your car battery so you can start it without a jump.

Inside, there's usually an SLA battery in the 17-20 amp-hour range. These are fine for running a CPAP for one or two nights before recharging. Check the amp-hour ratings when you buy, so you're aware of your capacity. Treat it like any other lead-acid battery.

Goal Zero

There are companies that sell portable power packs with built-in chargers, inverters (120 VAC out, see below), USB connectors for charging your cellphone, pretty much anything else you could possibly need, along with fancy meters to monitor your power status, the ability to attach extra battery packs for longer run time and even solar cells for recharging. Again, these typically have an SLA battery inside. The best known is Goal Zero. These will work well, but Goal Zero is top-dollar expensive. If you can afford it, great.

Alternative Battery Technologies

Lead-acid batteries are still common because they are cheap and well-understood. There are newer battery technologies that are much lighter and have a higher power density, but they're more expensive.

Lithium-ion or lithium-polymer batteries are good for getting a lot of power in a small space. Those are the batteries used in cellphones, tablets, and laptops. They take special chargers (usually built into the cellphone), and are pretty hard to find in large capacities. If you're going that route, do *not* take the cheap route – you run the risk of looking like a large version of a Samsung Galaxy 7 phone burning up. You may also remember a few years back where the Boeing 777 airliners were grounded for a time due to a large Li-ion battery pack catching fire. Not good.

A better solution that's starting to appear is lithium iron phosphate (LiFePO4, also known as LFP). This technology is significantly safer than Li-ion and easily available in large capacities. It is also amazingly light. A LiFePO4 battery the size of a 17 amp-hour Sealed Lead-Acid battery holds 25% more power but at one-third the weight. The only real down-side right now is expense – expect to pay 3-5 times the price of a similar-size SLA battery. They also require a special charger. Soon…

Battery (more than 12 volts DC)

If your machine uses something other than 12 volts DC, you're not out of options.

24 volt Batteries

One option to get to 24 volts DC, though somewhat unwieldly, is simply to hook two identical 12 volt batteries together end to end. This is guaranteed to work, though it doubles the cost and recharge pain, since you now have to handle and

recharge two batteries instead of one. It's not the best solution. You can sometimes find 24 VDC batteries as well, but they are relatively rare (read: expensive).

DC-DC Converter Power Bricks

If you're using a power brick to run your machine at home, you're converting wall power (120 VAC) to whatever your machine needs. You can now get a power brick that can convert 12 VDC to whatever your machine needs (for one common example: 12VDC in, 19VDC out). They aren't magic. If your CPAP needs 19 volts at 1.5 amps for 8 hours overnight, that's 228 watt-hours (1.5×8 = 12 amp-hours at 19 volts →12×19 = 228). At 12 volts, your battery demand will be still be 228 watt-hours, only this time it will be at 12 volts which works out to 19 amp-hours, plus a little extra for losses in the converter. Size your battery appropriately.

Inverters

If your machine will *only* run on wall power, your best power option is something called an "inverter". This hooks to a 12 VDC power source and puts out something resembling household AC wall power on the other end. Inverters can be notoriously inefficient; cheap models can waste 40% of your battery capacity. Further, the AC power put out by the really cheap inverters can burn out your equipment's power supply (ask me how I know this). Avoid them if you can. Be sure to look for an inverter that is specified to run laptops, and expect to spend $50-$100. A good (i.e. won't burn up your equipment) unit is:

http://a.co/8JuLbbE

Any "true sine-wave" inverter will work well, but those are often more expensive.

Extension Cords

If you have wall power in your general vicinity (a power pole nearby at Pennsic or maybe a cabin with power), you can run an extension cord. The advantage is pretty obvious; just plug it in like you do at home. There are disadvantages, though.

1) The longer the cord, the more voltage drop you will experience. Drop the voltage too low and your power supply will start to have problems. The voltage drop depends on the size of the extension cord (measured in something called "gauge" – the lower the gauge number, the heavier the wire), the length and the amount of current. It's not easy to calculate, though there are websites online that can do it for you. If you are running

only a typical CPAP machine, you can use a 100 ft. 16- or 18-gauge extension cord with a minimal voltage drop. The longer the run, the greater the voltage drop, or the heavier the gauge needed to minimize the drop. Heavier gauge = heavier cord, harder to wind, more expensive.

2) Laying an extension cord along the ground invites people to trip over it, especially inebriated folks at night. Tripping not only exposes people to injury, it can yank on the cord and unplug it unexpectedly. At Pennsic, it's common to bury extension cords when they cross walking paths.

If you're going to use an extension cord, also bring along a multi-plug expander, so you don't monopolize the outlet.

General Issues

• At Pennsic, CPAPs fall into the area covered by Disability Services. You need to check in with them to get a time slot at a charging station. At other events, check with the autocrat / event steward. They will often have provisions for powering or recharging medical devices.

• If you intend to use the battery for other purposes besides your medical equipment, such as charging cellphones or other consumer electronics, be sure to account for the extra amp-hours when you size your battery. You can charge a cellphone without much impact. If you want to run your laptop, you will draw a lot more power, which means you'll need a bigger battery.

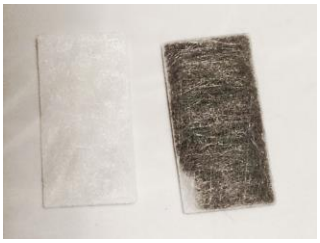
• Heated humidifiers add an enormous load to your power needs. Mine *triples* the energy usage. However, at Pennsic the relative humidity routinely reaches 100% at night. That means the humidifier will not be doing much since the air is already saturated with moisture. Your own situation may be different, but you should experiment to see if you can get along without the humidifier. If you can, your battery capacity will go much farther.

• Remember: you can use the battery at home to power your CPAP in case of a power outage. It's a good idea to use your battery once or twice a year at home, just for maintenance purposes.

• As a general rule, charge all lead acid batteries before you store them.

• You'll want to have some way to transport your battery to the charging station. Lead-acid batteries in the 50 amp-hour range capacity weigh 40 pounds or more. Little red wagons are good, as well as useful around camp and for ice runs.

• The air at Pennsic is notoriously smoky, especially at night. Your CPAP will be taking that smoke-laden air and pumping it straight into your lungs. If your CPAP is capable of using a disposable high-efficiency particulate filter, you should use it. At Pennsic, I replace my filter every two to three days. It starts out snow white, and it's almost black when I pull it out. That black stuff would have gone into my lungs if the filter wasn't there. (In this photo, the black filter had been used for **four days** at Pennsic.)



• The only real limit to the amount of battery power you can use overnight is how much you can recharge the next day. You can haul massive battery packs (if your car and back are up to it), but if you can't put as much energy back in as you took out, at some point you're going to run out. If your power needs are at that level, it's time to surrender and camp where there is commercial power available.

Alternative Power

I'm often asked if there is an alternative to taking your battery to a charging station. Perhaps an alternative power source, such as wind or solar, would work?

The answer is indeed yes. However, there are some issues that make alternative power less attractive than it might seem at first blush.

To begin with, you have to generate at least as much energy during the day as you use at night. In fact, you'll need to generate ***more***, since charging a battery is not 100% efficient. You need to put more amp-hours into the battery than you took out. If you used 6 amp-hours overnight, you'll probably need 6-7 amp-hours to get your battery back to where you started. So, in order to determine if alternative energy sources make sense, you will need to know how much energy you use in a typical day. In my own case, I found that my CPAP machine uses about 3-5 amp-hours a night. (I have a specialized meter that measures amp-hours.) Your situation will be different, and your exact numbers can be hard to determine. You can make a rough estimate by looking at the sticker on your equipment, then calculate *current draw in amps* × *expected run time in hours* × *1.4*. Keep this number in mind as you look at options.

Also, remember that you could always get days where the sun doesn't shine much, or the wind doesn't blow much. So, you'll need spare capacity to get through those days, or a regular charger to use as a backup.

Solar

> (Note: Since I first wrote this in 2011, solar panel prices have come down substantially, while solar panel efficiency has improved somewhat. When considered along with better power efficiency in medical equipment, this has moved the break-even calculation.)

You've probably seen little solar panels that you put on your car's dashboard and plug into the cigarette lighter. These are used to keep your car battery topped off if you're not going to start it for a while, and they work well for that purpose. However, if we are lucky they put out a whopping 0.1 amps in high sun. To produce 10 amp-hours, you'd need to use the panel for 100 hours. Not nearly good enough.

In May 2103, I purchased a solar panel that can produce 1.5 amp (20+ watts) in full sun. It's about 20×24 inches and cost $75. It needs a charge controller (http://a.co/5DBmLth for one example) and wiring, so add another $15-20 or so. For under $100, I can produce 6 to 8 amp-hours per day in good weather. Since my CPAP uses less than 5 amp-hours overnight, I need about 6-7 amp-hours per day to keep the battery charged. The math suggests and my experience shows that I am able to stay caught up using solar alone (as long as the weather cooperates).

Next up would be the solar panels that you can use to charge laptops. The best on one the market I can find right now is from California Solar Accessories. Their 40 watt folding kit can easily charge an 8-10 amp-hour battery in a day of good sun. That's better, but the cost is getting up there ($350+). Another good vendor is Powerfilm Solar (and their solar cells can be folded up or rolled up), but expect to pay similar amounts. GoalZero is good but *very* expensive. Harbor Freight kits are less expensive, but their panels produce less power per square foot and as a result are pretty large.

If you need more power and still need to be even remotely portable, we have to look at RV/marine power solutions. There are quite a number of options here, but they all have a couple of common issues: size and cost. You can produce a considerable amount of energy with panels that start about 10 square feet and up. That's a 3 ft. × 3 ft. or larger panel that you'd have to transport and accommodate somehow in your camp. It needs to be mounted so you can aim it at the sun, plus it needs a clear view of the southern sky. And, we all know what they look like. Costs of these solutions run in the $500-$1000 range which includes all the required accessories (like a charge controller) but doesn't include a battery or mounting system. Once you start requiring this amount of power, it is probably easier to camp where commercial power is available.

Wind

There are several elegant wind power systems designed for RVs or sailboats. The Air-X 12 volt wind generator works extremely well in winds starting at 7 miles per hour (day or night) and can easily produce more than enough power to handle a typical CPAP, plus other equipment. Expect to pay $750 for the generator plus additional cost for the hardware to get it safely up in the air, plus you'll still need a battery. However, you should also expect it to look ***horribly*** modern. It's also not silent. Wind generators make a '*whisk-whisk*' noise that other campers might find objectionable. It's unlikely that you would get sufficient wind unless you're camping on the Serengeti. For both the solar and wind options, be prepared to negotiate with your camping neighbors.

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