Tech Topics:

Battery Health Analysis by Computer

By Mike Busch

There's a nifty, inexpensive gizmo that lets you analyze the condition of your aircraft battery and know exactly when it needs to be replaced. (It works for your car, laptop, and cellphone battery, too!)

How do you decide when it's time to replace your aircraft's battery?

Some owners wait until the battery starts showing obvious signs of weakness, such as slow cranking during engine start. This is a high-risk approach, because the first operational indication of a weak battery might just be that you find yourself stuck in Yankton, SD or Norridgewock, ME on a cold winter Sunday morning.

Other owners change their battery every two or three years, just to be on the safe side. This approach reduces the risk of getting stuck somewhere, but at the expense of discarding batteries with lots of useful life left in them. (I did three-year battery replacements on my T310R for many years, until the cost of my Gill G-246 battery climbed above $300.)

The aircraft battery manufacturers—Teledyne-Gill and Concorde—both call for their batteries to undergo regular capacity testing. Gill calls for performing a capacity test after the battery has been in service for 12 months or 800 hours (whichever comes first), and then every 6 months or 400 hours thereafter. Concorde calls for a capacity test after 12 months or 600 hours, and then every 12 months or 200 hours thereafter. Gill recommends that the battery be replaced when it falls below 80% of rated capacity; Concorde recommends replacement below 85% of rated capacity.

Capacity testing

Both Gill and Concorde recommend similar procedures for battery capacity testing. First, the battery is connected to a battery charger and charged to full. The charger is disconnected and the battery is allowed to "breathe" for at least an hour to stabilize the battery chemistry and temperature. Next, the battery is connected to a capacity tester which discharges the battery at a specified current (amperes), and measures how long it takes for the battery to reach a fully discharged state. A fully charged 12-volt aircraft battery puts out about 12.6 volts, and is considered fully discharged when the voltage under load reaches 10.0 volts. For 24-volt batteries, the corresponding voltages are double: 25.2 volts fully charged, 20.0 volts fully discharged.

If the time it takes to discharge the battery from fully charged to fully discharged is at least 80% or 85% of rated capacity, then the battery is charged up again and reinstalled in the aircraft. If the battery is depleted more quickly than that, it is retired and a new battery is installed.

Capacity testing is the most reliable and efficient method for knowing when it's time to retire a battery. Unfortunately, not too many aircraft maintenance shops and even fewer aircraft owners have access to a proper battery capacity tester. The test equipment recommended by Gill and Concorde costs well over a thousand bucks.

Aircraft batteries cost $200 to $500 a pop. The best way to decide when to replace one is by doing regular capacity tests.

This Gill TCT-1000 battery tester costs well over $1,000. Not too many maintenance shops have one.

West Mountain Radio CBA II

A few months back, a CPA member put me on to nifty battery tester manufactured by West Mountain Radio in Norwalk, Connecticut (www.westmountainradio.com), a company that specializes in electronic gadgets for ham radio operators, radio-controlled aircraft enthusiasts, and other hobbyists. The company's "CBA II" computerized battery analyzer costs only $120, so I decided to order one on a lark. The CBA II is used primarily by RC model aircraft enthusiasts, but it works fine with any kind of battery and its price is certainly right.

The CBA II is surprisingly tiny, about 2x2x3 inches, most of which is occupied by a heat sink and cooling fan. (See Figure 3.) It comes with a USB cable to plug into your PC and a CDROM containing drivers and application software. Note that your PC must be running Windows—there is no support for MacOS or Linux. Both 32-bit XP and Vista are supported, but 64-bit drivers have not yet been released. I installed the software on my tiny WinXP sub-notebook (Asus EeePC) for use at the hangar, and it worked great. I also installed it on an HP notebook running Windows Vista and it worked fine there as well. It'll work on a desktop computer, too.

The CBA II requires no external power. It gets all the power it needs from the battery under test and the USB port of your computer. Since capacity testing of a big lead-acid battery usually takes hours to go from fully charged to fully discharged, you'll probably want to run your notebook computer on AC power so it doesn't shut down in mid-test.

Figure 3 - The CBA II computerized battery analyzer from West Mountain Radio costs just $119.95. It works on virtually any kind of battery, including aircraft batteries

Using the CBA II

As mentioned earlier, the first step in doing a battery capacity test is to hook up a battery charger and bring the battery up to a full charge. (For safety's sake, please remove the battery from the airplane.) One way to determine that the battery is fully charged is to measure the battery voltage while the battery is charging and keep charging until the voltage stops rising. Another is to measure the specific gravity of the electrolyte with a hydrometer and keep charging until it stops rising. Once the battery is fully charged, disconnect the charger and let the battery stabilize for an hour or more.

Position the CBA and computer in the vicinity of the battery to be tested. Connect the CBA to the computer with the supplied USB cable, and launch the CBA application. Once the CBA and computer are talking to one another, you can connect the CBA to the battery via the unit's heavy red and black wires, taking care to connect red to positive and black to negative. (See Figure 4.) At this point, the CBA application should start displaying the battery's open-circuit voltage (which should be about 12.6 or 25.2 volts for a regular flooded-cell lead-acid battery). Note: If you connect the CBA with reverse polarity, it'll blow a fuse in the unit—so don't.

On your computer, tell the application that you're ready to perform a test by clicking on the icon. A dialog box will pop up and ask you to set up the test parameters. (See Figure 5.) Those parameters include:

- Test name (e.g., "my Gill G-246")
- Battery type (e.g., "lead-acid")

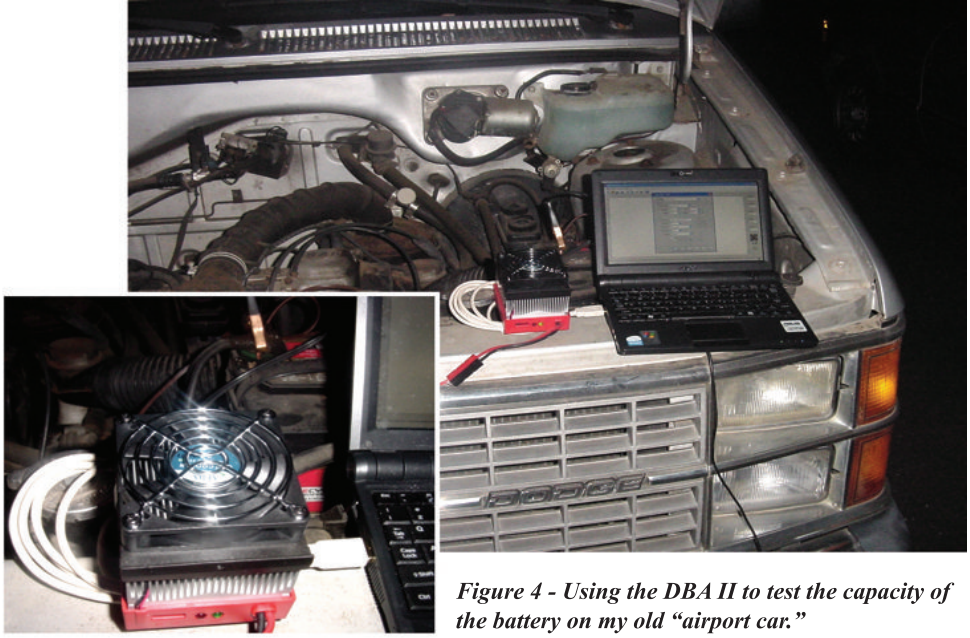

Figure 4 - Using the DBA II to test the capacity of the battery on my old "airport car."

- Rated battery capacity in ampere-hours
- Number of cells (either 6 or 12 for aircraft batteries)
- Fully-charged voltage (either 12.6 or 25.2 for aircraft batteries)
- Fully-discharged (cutoff) voltage (either 10.0 or 20.0 for aircraft batteries)
- Test amps (see below)
- Graph type (ampere-hours, watt-hours, or minutes)

Once satisfied with the setup, click the "Start" button to start the test. The red LED on the CBA will illuminate, its little fan will start running, and the application will start to graph the battery voltage on the computer screen. (This would be a good time to go have a leisurely lunch while the test progresses.)

Over a period of hours, the battery voltage will gradually decline as the CBA discharges the battery at the specified rate. You can watch this on the graph in real-time (assuming you have nothing better to do). Ultimately, the voltage will reach the specified cutoff voltage (10.0 or 20.0 volts for lead-acid aircraft batteries), at which point the CBA will automatically terminate the test. (See Figure 6.) When the test is complete, you have the option of saving the test results to a file, printing them to a printer, and/or exporting them to a .CSV file that you can import into Microsoft Excel, Access, and other software.

The final step, of course, is to charge the battery back up to full charge and then reinstall it in the aircraft.

CBA Limitations

The major limitation of the West Mountain Radio CBA II is that the unit is restricted to a maximum discharge rate of 100 watts. This equates to 8 amps for a 12-volt battery and 4 amps for a 24-volt battery. The software enforces this restriction to prevent damaging the CBA.

The standard capacity testing instructions from Gill and

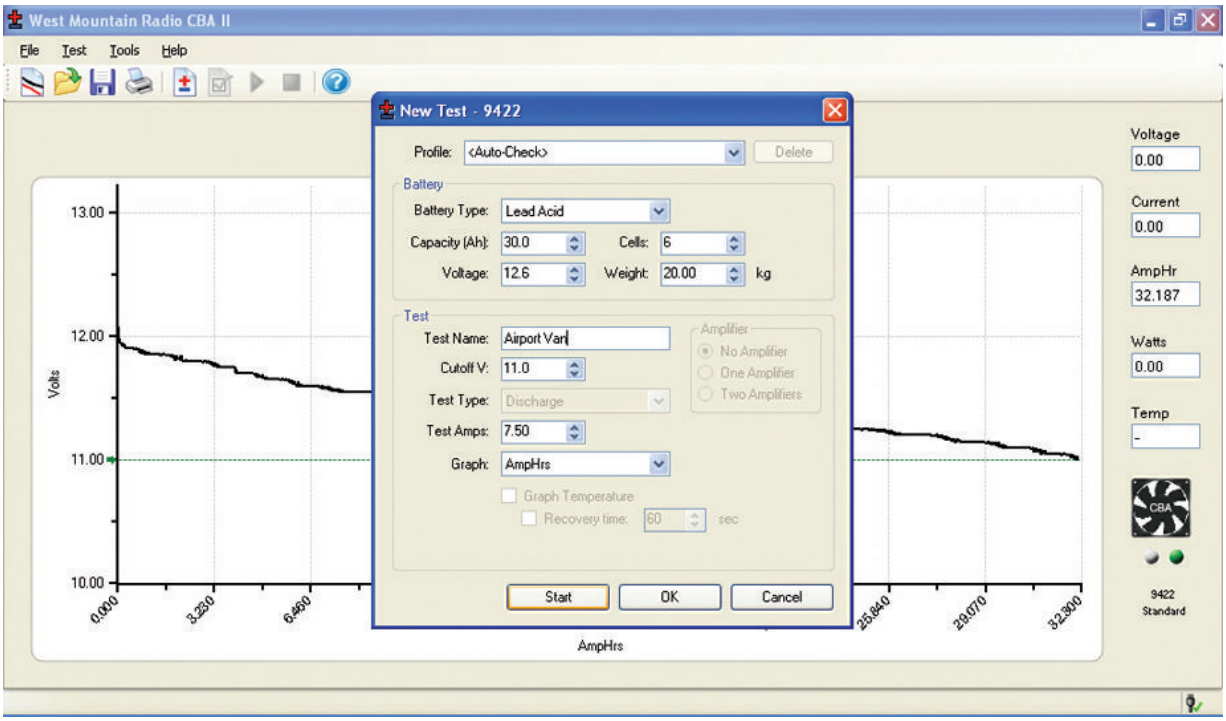

Figure 5 - Setting up the test parameters for the airport car battery.

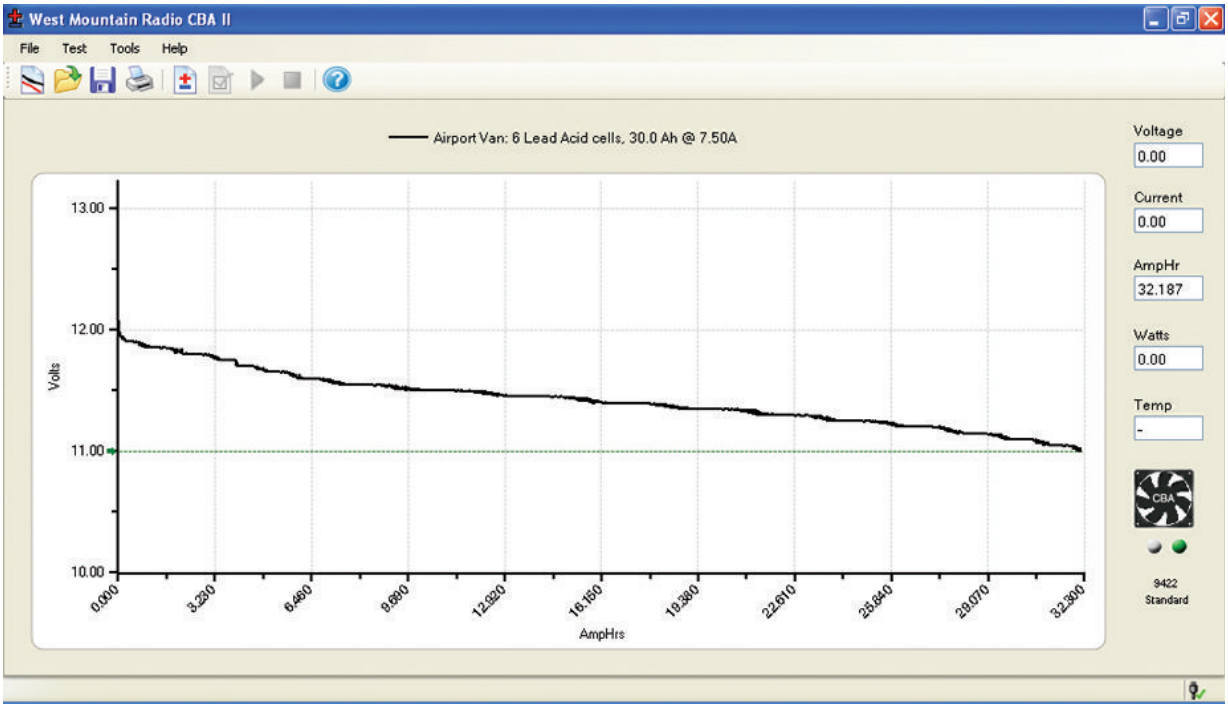

Figure 6 - Discharge test shows that the battery is still good for 32 ampere-hours at a 7.5-amp discharge rate, so I'll keep it in service awhile longer.

Concorde call for discharging the battery at a significantly higher rate. Gill calls for discharging at the "30-minute capacity rate" (i.e., a current great enough to fully discharge the battery in 30 minutes), while Concorde calls for discharging at the "60-minute capacity rate." For common lead-acid aircraft batteries, this equates to a discharge rate of 20 to 40 amperes. Such discharge rates greatly exceed the 100-watt limitation of the CBA II.

One solution to this problem is to purchase a "CBA Amplifier" from West Mountain Radio (see Figure 7). The amplifier has two fans and a considerably larger heat sink, and raises the CBA's power limit from 100 to 500 watts. That's enough to stress-test your aircraft battery at its 30- or 60-minute capacity discharge rate. However, the CBA Amplifier is rather pricey at $729.95, probably more than you want to spend unless you're testing a whole lot of batteries.

The other solution (and the one I chose) was simply to perform the capacity tests at the CBA's 100-watt discharge rate. Reduced-rate capacity testing is considerably less stressful on the battery than testing at the high rates ("emergency rates") suggested by Gill and Concorde. Gill specifically authorizes testing at reduced rates in its Instructions for Continued

Figure 7 - This CBA Amplifier allows the CBA II to load batteries up to 500 watts (instead of 100 watts), but it costs $729.95.

Airworthiness, and provides detailed data for its batteries at a wide range of discharge rates. (http://gillbatteries.com/battery_PDF/Flooded_Service_Manual.pdf.) Concorde's ICA doesn't mention testing at less than the 60-minute rate, but since Concorde doesn't mandate capacity testing at all (i.e., doesn't list it as an airworthiness limitation), I can't see any regulatory reason not to do reduced-rate capacity testing on Concorde batteries as well.

It seems to me that one good approach would be to perform a CBA capacity test (at a 100-watt rate) on a brand new battery before installing it in the airplane. Mark the test results (in CBA-measured ampere-hours) on the battery for reference. Then re-test the battery once or twice a year (again at a 100-watt rate) and compare the results with the new-battery capacity. If it drops below 80% to 85%, it's time to retire the battery.

By replacing batteries on-condition rather than on an arbitrary timetable, you'll most likely get an extra year or two or three out of your aircraft battery, so the CBA will pay for itself quite quickly. Regular capacity checks will also give you confidence that your battery won't leave you stranded.

The CBA isn't limited to aircraft batteries. It works great on any sort of rechargeable battery—lead-acid, NiCD, NiMH, Li-ion, etc.—in any sort of application—automotive, marine, computer, cell phone, etc.—so you'll probably find yourself using it a lot. Besides, it's way cool!

Tech Topics is a monthly column written by Mike Busch of CPA's technical staff. Mike is a longtime CPA Magazine columnist, co-founder of AVweb and teaches Savvy Seminars, www.savvyaviator.com, for aircraft owners and mechanics. Mike is the National AMT of the year for 2008. Mike owns, flies and maintains a 1979 Cessna T310R based in Santa Maria, California.