Testing Intervals
for Aircraft Nickel-Cadmium Batteries

By Joseph F. Mibelli

V0.4 – 12 May 2011

7880 NW 56th Street
Doral (Miami) Florida 33166
305-592-2272
305-599-6893
www.jfmeng.com

Introduction:

- Aircraft Nickel-Cadmium batteries require periodic testing to determine airworthiness[1].
- Bench tests have to be performed to determine if the battery performs in accordance to the specifications of the manufacturer of the battery[2] or the manufacturer of the aircraft, or accessory where the battery is used.
- The testing requirement is to determine if the battery is capable of delivering the required current for the expected amount of time. For engine starting and more importantly for emergency situations to power avionics, start the APU[3], etc.
- The life of the battery is directly related to the maintenance that it receives
- What needs to be determined is the proper frequency of testing (testing intervals).

Test Details:

The principal test is Capacity.

In this test, the battery is discharged at the rated current for one hour[4]. The test is successful if the battery voltage remains above the equivalent of one volt per cell. For a typical 40A-Hr battery, this means that the battery, being discharged at 40A, must last for one hour to a terminal voltage of no less than 20V. However, since a battery is made up of 20 individual cells, capacity failure is more exactly considered when any one of the cells shows a voltage of less than 1V, even though the overall battery voltage could be well above the minimum voltage.

Batteries may fail the capacity test for a variety of reasons and one of them is cell imbalance. With 20 cells making up one battery and with the cells not being 100% identical, it is expected that over time cells will perform differently resulting in one or more cells lagging behind the others significantly. Therefore, it is necessary to exercise the cells in the battery to restore the performance balance.

This exercise is the deep cycle, where all cells are discharged to zero, recharged and retested for capacity.

Cells may also fail the capacity test because they fail to charge properly. For this, a charge acceptance test is necessary to determine the condition of the cell separator and to verify and adjust the electrolyte level.

Finally, cells may fail simple because they have reached their end of life. In this case, no amount of exercising will be able to restore their performance.

Charge acceptance is also of importance to determine the integrity of the cell separator. In this case, a combination of measurements of cell/battery voltage and temperature are performed. Any increase in temperature and/or a decrease of voltage, or simply a failure for the voltage to rise to proper levels, is taken as damaged cell separators.

Failure to perform these tests at sufficiently short intervals can lead to catastrophic in-flight thermal runaway.

[1] See: http://www.saftbatteries.com/SAFT/UploadedFiles/Aircraft/PDF/tn5.pdf
[2] As it is described in the OMM (General Battery Manual) or the CMM for each battery
[3] Auxiliary Power Unit
[4] This assumes that the battery is fully charged

Testing Intervals:

What dictates the testing interval?

The manufacturer of the battery may specify a number of hours (or period of calendar time). The same for the manufacturer of the aircraft or accessory, but what really determines the proper testing interval is the result of the bench tests.

There are two figures of merit that need to be used: Degree of imbalance and water consumed.

In all cases, the weakest cell is the one that will determine the point at which the capacity test will fail. When cells are imbalanced, meaning that there is a large gap in capacity reserve from the strongest to the weakest cell[5], the capacity test will be marginal or will fail altogether.

There is also the requirement to verify the level of the electrolyte[6]. The electrolyte level test provides information on how much water has been lost from the electrolyte. This is needed because when the battery is connected to the 28V bus it continuously loses water due to the normal overcharge process.

Cells have a specified maximum water consumption that if exceeded can result in overheating and deterioration of the cell separator[7]. Cells that repeatedly require water greater than or near the maximum are an indication that the battery needs to be tested more frequently (shorter intervals). This can vary considerably and is dependent on duration of flights, engine/APU starts, temperature, etc.

[5] There should be less than 50mV (0.05V) difference between the highest and the lowest performing cell
[6] This is done at the end of the charge only.
[7] When the cell separator fails (from microscopic holes to large ruptures), cells can develop a dangerous and catastrophic failure called thermal runaway.

Summary:

- The life of the battery is directly related to the maintenance performed.
- Under normal use conditions, a properly maintained battery will last five years or better (with a few cell replacements).
- In contrast, an improperly maintained battery can easily fail in less than six months.
- Cost savings achieved by stretching battery testing are quickly surpassed by the cost of cell/battery replacements.
- Start with a test interval much shorter than recommended. If tests indicate that the battery is performing properly, then increase the testing interval until performance degrades (cell imbalance, water consumption, etc.). Shorten the interval somewhat and establish this as the test interval. Verify in subsequent cycles and adjust as needed.

JFM Engineering has over 30 years in the development and manufacturing of precision instruments for the testing of batteries and an FAA certified repair station for the testing and maintenance of aircraft batteries of all types.

For additional information, please contact the sales department at 305-592-2272 or visit our website www.jfmeng.com for complete information on our products and services.
