

AIRCRAFT BATTERY TESTING

Definitions and General Information



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1. Definitions of Aircraft Battery Servicing

1.1 Purpose of Battery Testing:

To certify that the battery is capable of performing in the aircraft as specified¹

1.2 Reasons for Battery Testing:

Batteries will degrade in performance with normal usage, while being subjected to continuous charging and while being left in storage².

1.3 Types of Tests:

1.3.1. CHARGE ACCEPTANCE:

The ability of the battery to convert electrical current into charge stored in the plates of the cells.

1.3.2. CAPACITY³:

The ability of the battery to deliver current for a minimum amount of time while remaining above a minimum voltage.

1.4 Tests performed:

Note: Description of tests refers primarily to Nickel-Cadmium batteries. Additional comments are provided for *Lead-Acid* batteries.

1.4.1. Top charge:

- Top charge is the simplest type of service for all types of batteries. Batteries are "topped off" before being put on the aircraft to compensate for self-discharge while in storage.
- Top charge is also used to determine the proper electrolyte level. Water is normally lost during usage and it is also lost due to evaporation. When the battery reaches full charge, the electrolyte is at its maximum level; distilled water is added as required.
- The top charge process is also used to measure cell voltages, to determine that each cell reaches the proper charge voltage and to check if any cells exhibit a temperature rise and/or drop in their voltage under constant charge current (topping current).
- *Lead-Acid batteries are also top charged, and if of the flooded type, the specific gravity and level of electrolyte is also tested and adjusted as necessary. On sealed batteries, the specific gravity of the electrolyte cannot be measured.*

¹ Testing for Certification is a process requiring specialized equipment (Battery Charger-Analyzer) and battery specific test procedures.

² Failure to test batteries at the prescribed intervals could result in costly AOG situations and catastrophic in-flight emergencies.

³ Even though Capacity Test is perceived as the most important test, Charge Acceptance is equally as important in determining the performance of the battery.

1.4.2. Capacity Test:

- This test determines if the battery will deliver the required current. After receiving a full charge, the battery is subjected for one hour to a typical discharge current of 100% of its rating. If none of the cells drop below 1V, the battery passes the capacity test. It is then recharged and returned to service.
- If one or more of the cells drop below 1V, even if the battery as a unit does not drop below 20V (for a 20 cell battery) the battery fails the capacity test.
- What happens next depends on the individual condition of the cells. If the cell voltages are reasonably similar (balanced), the battery is recharged and re-tested for capacity. If the cells are heavily unbalanced, then, the battery is subjected to a full discharge (deep cycle).
- If after three tries, one or more cells fail to meet the capacity test, they are replaced. If more than 20% of the cells need to be replaced, it is recommended that either all the cells be replaced or that the entire battery be replaced (this is done to avoid a significant mixture of new and used cells).
- *Lead-Acid batteries are similarly tested for capacity, but with no individual cell readings (terminals for individual cells are not available).*

1.4.3. Deep Cycle:

- A battery where the cells are heavily unbalanced, either as received for testing or after failing a capacity test, must be fully discharged. This allows all cells to start from zero in the subsequent recharge, thus restoring the balance in the cell voltages⁴.
- *Lead-Acid batteries are never discharged to zero during testing as this could result in irreversible damage⁵*

1.4.4. Overhaul:

- Batteries are not repairable, at least not with the same meaning that we apply to other devices⁶.
- The basic component of the battery is the cell (*or cell block in a Lead-Acid battery*).
- If cells fail to perform, they are replaced. The same is true for other parts such as temperature sensors, connectors, links and fasteners.
- A battery received for overhaul will get fully disassembled and washed. The cells will be checked for leakage (cracks).
- Interconnecting hardware, (connectors, links, screws, nuts and washers), are normally cleaned. If burned, corroded, or otherwise deemed unsuitable, they are replaced.

⁴ This cycle is normally repeated, up to three times, if cells fail to “come up” to rated performance.

⁵ When Lead-Acid batteries are allowed to remain in a low charge state (below the minimum voltage), sulfation will take place that will eventually render the battery useless.

⁶ Batteries can only be “repaired” by replacement of non-conforming parts.

1.5 Duration of Tests:

Battery testing is a lengthy process. It is important then, for customers to understand and accept that there is no such a thing as “quick turnaround” when testing batteries for certification⁷.

- The longest test is the deep cycle because it involves many cycles of charge and discharge and this may require from 2 days to an entire week depending on the condition of the battery, as follows:
- The first test on the battery is a capacity test to determine the as received charge state of the battery. Even though the capacity test is usually only one hour, the battery gets hot and has to be allowed to cool down (usually overnight) before it can be recharged⁸.
- Subsequent to the As Received Capacity Test, the battery is charged up, lasting four to six hours, depending on the manufacturer. A new capacity test can now be performed.
- If it passes the capacity test and the cells are reasonably balanced, the battery can be re-charged and eventually released.
- If the capacity test fails, a total discharge needs to be performed (all cells discharged to 0 volts), followed by re-charge and a new capacity test.
- This cycle can be repeated up to three times to allow cells that may have failed capacity to get reconditioned.

2. Certification

- 2.1 Certification of a battery means that the battery has passed all bench tests as specified by the manufacturer of the battery⁹.

3. Warranties

- 3.1 Warranties are provided by the manufacturers of the batteries, provided that the batteries are used and serviced in accordance to their specifications.
- 3.2 JFM Engineering guarantees that all tests are performed in accordance with the specifications provided by the respective manufacturers of the batteries.

⁷ Any attempts to short circuit the process to reduce the turnaround time can easily result in incomplete testing with all its negative consequences.

⁸ Since batteries are not expected to exhibit temperature increases during charge, it is then imperative for the battery to be allowed to cool down before it can be charged.

⁹ Certification is not an implication that the battery will perform for any determined period of time.

4. Responsibilities

- 4.1 It is the user's responsibility to use the battery in accordance with the specifications of the manufacturer of the aircraft and/or the manufacturer of the battery.
- 4.2 It is the responsibility of the end user to perform periodic tests as prescribed by the manufacturer of the aircraft and/or the manufacturer of the battery. This implies removal of batteries for testing and servicing at prescribed intervals of time and/or flight hours.
- Failure to observe the prescribed test intervals may result in premature failure of performance and non recoverable performance degradation, requiring the replacement of a large number of cells or the entire battery as applicable.
 - If batteries are to be stored for long periods of time (6 months), they should be discharged and stored with all cells shorted.
 - If batteries are to be maintained in ready condition, a Trickle Charger may be used to offset the self discharge of the Nickel-Cadmium Cell (usually 1mA per A-hr). Maintaining batteries in trickle charge for periods of over three months can lead to cell degradation, thus requiring periodic re-testing (water level, etc.)¹⁰
- 4.3 JFM's responsibility is limited to the re-testing of batteries that are found to be non performing.

5. Our Battery Test Operation:

- The JFM Engineering Battery Shop is equipped with our own high accuracy Charger-Analyzers and our own computerized Data Acquisition and Charger-Analyzer control system.
- Battery service is performed under stringent procedures geared to returning battery performance as dictated by the battery and airframe manufacturers¹¹.
- All test details are fully recorded and they are maintained in our electronic database and paper filing system.
- Our Battery Shop is affiliated with Aero Quality Sales, which gives us access to all required cells and other replacement parts.

¹⁰ Note that JFM Engineering can provide "ready to go" storage for batteries, including all needed intermediate testing.

¹¹ Battery test information is usually obtained from the individual battery CMM or the Battery Manual (OMM).