Technical Notes

Saft an NiCd aircraft battery maintenance

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1. Why maintenance is required?

Since it is the last link in the emergency chain, an aircraft battery plays an essential part in aircraft safety. The condition of the battery must be verified in order assure this major role: safety. It is this verification that is ensured by maintenance.

All aircraft batteries require checking and maintenance in order to ensure their safety of operation when installed and their ability to perform their required functions, especially in emergency conditions on board the aircraft. Maintenance checks also permit any problems to be identified and rectified. The maintenance interval is the period for which correct operation is assured with a low probability of failure and allows high levels of MTBUR and MTBF to be achieved. Apart from the question of safety, the avoidance of failure on board the aircraft, with consequent costly impact on delays, reduces operational costs.

Saft has developed, its maintenance philosophy in co-operation with users over many years and continues to make improvements. Correct and adapted scheduled maintenance enhances safety and reduces operational costs.

2. Maintenance procedures

Detailed maintenance procedures are normally defined in a Component Maintenance Manual (CMM) specific to a particular battery or in an Operating and Maintenance Manual (OMM) that describes general procedures for a battery not covered by a CMM. The CMM takes priority over the OMM. The CMM / OMM procedures are not necessarily specific to a particular aircraft, or to the different operating conditions which may be experienced by a specific aircraft They do not therefore normally give a specific maintenance interval.

The CMM procedures may be incorporated or referenced in the aircraft manual by the aircraft manufacturer. The aircraft manufacturer also specifies maintenance intervals based on Saft recommendations in relation to the particular aircraft and its usage.

3. Saft distinguishes three types of maintenance

3.1. Periodical check

The periodical check consists essentially of voltage and insulation checks, discharge of residual capacity and recharge with electrolyte level adjustment. The main purpose of the periodical check is to replace water which is consumed by electrolysis during battery overcharge. It is normally applied between regular checks, but can be omitted if the water consumption measured at the regular check is within allowable limits. A correctly equipped workshop can accomplish this task in 8-9 h with a labour time of 1 h.

3.2. Regular check

The regular check is the same as the periodical check except that the battery is subject to deep discharge ('balancing'), followed by a capacity check cycle. A correctly equipped workshop can carry out a regular check in 24 h with a labour time of < 2 h.

A battery consists of a certain number of cells which have necessarily slight differences in terms of electrical resistance. These differences lead to different behaviour in terms of charge efficiency and its corollary, water consumption. The charge efficiency differences result also in unbalancing between cells. Because charging current is limited by total battery voltage, whereas individual cells in the battery (because of normal cell to cell variation will not have a uniform voltage) the capacity available from each cell will vary.

The deep discharge eliminates the imbalance between cells that arises from voltage limited charging: Deep discharge also eliminates any voltage depression which can build up through a number of different phenomena such as memory effect.

The capacity check is an important indicator of battery condition: a minimum capacity after full charge is required to guarantee the on aircraft performance and it is one of the criteria that defines battery end of life. For VHP, VXP and CVH cells the minimum is normally 100% of rated capacity while for VO and VP cells it is normally 85%.

3.3. General overhaul

The general overhaul is the same as the regular check except that the battery is subject to disassembly and detailed cleaning and inspection. A correctly equipped workshop can carry out a general overhaul in 24 h with a labour time of < 3 h.

The opportunity is taken during overhaul to check the sensor assembly which, although designed to resist the battery environment, cannot survive indefinitely.

It is recommended that the general overhaul be carried out annually. Exceptionally, and according to operator experience, this period may be longer, for example in the case of light usage.

3.4. Recording

It is very important to record the battery check values (capacity, end of charge voltage, water consumption) as required in the battery logbook for each maintenance. It is recommended that an operator tracks these maintenance data in order to verify the interval is correct in relation his particular operation. This may also allow the interval to be extended if the data justify it.

4. Maintenance training.

Saft offers comprehensive battery maintenance training which deals in detail with the both theoretical and practical aspects of maintenance. Details can be found on its website:
www.saftbatteries.com

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5. Maintenance interval

5.1. Basis for interval

The aircraft manufacturer is responsible for defining the usage and function, including maintenance intervals, for aircraft batteries installed in its aircraft, in the same way as for other equipment. Saft only provides recommendations that require the agreement of the aircraft manufacturer.

Two principal factors are taken into account in recommending the maintenance interval:

- energy available for emergency requirements,
- electrolyte reserve.

Both depend on the battery charging system (float charge, dedicated charger, DC generator, TRU), battery operating temperature, type of starting, number of starts, flight duration, ground operation and the battery technology. These affect the ratio of capacity charged / capacity discharged and the capacity overcharged. An other issue to take into account will be the overcharge voltage versus the number of cells. The higher the voltage / cell, the higher is the overcharge current and the higher the overcharged capacity.

The overcharged capacity is directly related to the electrolysis of water from the electrolyte and hence the consumption of the electrolyte reserve. (every 3 Ah of overcharge leads to the electrolysis of 1 cm^3 of water). When the water reserve has been consumed, the result is :

- dried out cells with a significant risk of permanent damage,
- internal short circuit,
- overheating,
- thermal runaway…

As far as the battery is concerned, maintenance interval depends on operating hours (time the battery is connected to the system). The relation with aircraft flying hours therefore depends on the total of ground operating and flying hours. The ratio of operating to flying hours is typically a minimum of 1.2 and can reach as high as 2.

5.2. New programmes or applications

Saft is naturally prudent in introducing a new product in a new programme or, application, so it defines an initially conservative interval. This is because there is often a difference between theoretical analysis or bench tests under controlled conditions and real field experience with different operational patterns and environments. For example, a battery could stand more than 2000 operating hours in laboratory tests but only 800 operating hours in real use.

Saft works together with the constructor and its operators to fully support the introduction by analysing the operator data that justifies future interval extension. In these cases we request to record in detail the water consumption and capacity for the first discharge and recharge after removal from the aircraft during a preliminary period of about one year. When sufficient data is available, a general extension for all operators may be justified.

5.3. Interval extension for existing users

In order to verify the validity of an extended interval Saft recommends the operator to review the maintenance records for a minimum period of 12 months under the same operating conditions and to be certain that these operating conditions will continue. It should be noted that for water consumption, the maximum water addition of any one cell, in a battery, during the period reviewed is the limiting factor rather than the average of all cells, in this battery.

Provided that the operator has evidence that, with an extended interval, the forecast maximum water addition is below the reserve volume and the electrical performance of the battery on removal from the aircraft will be satisfactory, it is in order to proceed. If the operator proceeds, the maintenance records must continue to be monitored in order to detect any adverse effects.

Modification of the maintenance interval may require the agreement of the aircraft manufacturer or the Certification or Approval Authorities. It is the operator's responsibility to satisfy the authorities that Saft's recommendations are followed. Saft cannot itself underwrite a proposed extension, but can assist if necessary in an analysis of the records.

6. Conclusion

Battery maintenance, following procedures developed by Saft over many years, contributes to the safety and reliability of aircraft operation. Using these preventative procedures has proved less costly than carrying out curative on-condition maintenance and pays significant dividends in terms of operating costs because unscheduled removals are minimised.

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