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AERONAUTICAL INFORMATION CIRCULAR

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MAINTENANCE - AVIONICS

OPERATIONAL AND MAINTENANCE PRACTICES FOR NICKEL-CADMIUM BATTERIES

1. This circular provides guidelines for more reliable Nickel-Cadmium battery operation through sound operational and maintenance practices.
2. Heat is a major cause of Nickel-Cadmium battery problems. If this is kept in mind, recommendations concerning battery maintenance will be readily appreciated. Failures are most prevalent where the batteries are charged by the constant potential method directly from the DC bus, rather than by a separate battery charger. (Refer RSA AD No. 73-164 See Electrical 3).
3. A combination of high battery temperature and overcharging can lead to a condition termed “thermal runaway”. Under a constant potential charging regime, the high initial inrush current drops sharply as the battery accepts charge and approaches a “full charge” conditions. Theoretically, the charging current should continue dropping and eventually approach a zero value during overcharge. However a rise in battery temperature at this point will produce a slight decrease in battery internal resistance of the battery and a corresponding rise in charge current. The resultant rise in current will cause a further increase in battery temperature which will be accompanied by a further drop in battery resistance, progressively generating enough heat which can destroy the separators in a cell or cells and which could finally result in the total destruction of the battery.
4. Battery overheating can be caused or accelerated by the following factors which are related to operational and maintenance practices:
   4.1. frequent or lengthy engine starts at very high discharge rates;
   4.2. aircraft generator bus voltage too high or in an uncontrolled fluctuating condition;
   4.3. loose intercell (link) connections;
   4.4. low cell electrolyte level;
   4.5. leakage currents between cell and battery container and airframe ground;
   4.6. inadequate ventilation of battery or battery compartment;
   4.7. poor placement of battery (in aircraft areas known to reach unsuitably high temperature levels);
   4.8. high initial charging currents on hot batteries;

4.9. unbalanced cells;

4.10. use of unregulated or poorly regulated ground support equipment to charge a battery, especially on a “hot” battery, as in the case of an aborted engine start.

5. Operating practices. To provide increased reliability it is recommended that certain operating practices be observed:

5.1. service batteries at the interval recommended by the aircraft and battery manufacturers or more frequently depending upon the following variables:

5.1.1. hard or frequent engine starts

5.1.2. duty cycle for battery (usage hours)

5.1.3. outside ambient operating temperature

5.1.4. aircraft generator voltage regulator setting

5.2. When experiencing hard engine starts follow manufactures recommended rest periods between starts. Prolonged engine cranking can cause excessive battery discharge current resulting in high battery temperatures.

5.3. When a series of short duration flights are planned, consider the use of well-regulated external power supplies of proper voltage for engine starts. Continued use of the battery for engine starts during a series of short duration flights, results in the battery undergoing heavy discharge cycles accompanied by incomplete charge cycles. This can lead to cell imbalance, possible battery overheat, and loss of battery capacity. Proper battery condition and conservative use of the battery is important for all operations.

5.4. Periodic checks of voltage regulator settings are necessary especially where high ambient temperatures are encountered. Care should be taken to ensure that the voltage is measured at the bus: experience has shown that on some aircraft, when the voltage is set by checking the voltage at the regulator terminals, it is possible that the bus voltage can be as much as ½ volt higher than the voltage at the regulator. A voltage regulator set for cold temperature operation and allowed to operate at this setting in a high ambient temperature, would bring about an increase in charge current and a rise in battery temperature. Table 1 is a guide to regulator settings for high ambient temperature climates.

Table 1

Battery temperature	**Constant potential voltage**
Up to 27°C	28,5 Volts
28-38°C	28,0 Volts
39-54°C	27,5 Volts
55-60°C	27,0 Volts

5.5. Careful observation of the aircraft bus voltage and load current will provide an indication of the charge voltage and current applied to the battery. A persistent increase, decrease, or fluctuation of the aircraft bus voltage or load current indicates an abnormal condition. Initiate corrective action as soon as possible as these conditions may result in either an overcharged or undercharged battery and possible failure. An increase in load or charge current as indicated on the aircraft load meter, especially during normal cruise, with no additional circuits being energised may be an indication of the battery overheat or failure.

5.6. It is not recommended that Nickel-Cadmium batteries be charged in the aircraft by a ground power unit. External power units are probably the least considered component in relation to Nickel-Cadmium batteries. These power units are not always well regulated nor are they necessarily set at the correct voltage in relation to ambient temperatures (refer to Table 1).

5.7. During extended ground operation keep the battery loads to a minimum and ensure there is adequate battery compartment ventilation. When the outside ambient temperature is high, additional ventilation may be provided by opening the battery compartment access door.

6. Maintenance practices. For maintenance procedures follow the manufacturer's instructions regarding periodic servicing, capacity checks, and reconditioning to ensure a more reliable and properly conditioned Nickel-Cadmium battery. The following areas should be given special attention:

6.1. Separate shops, equipment, and tools are recommended for servicing Nickel-Cadmium and lead acid batteries. Anything associated with lead acid batteries (acid fumes included) that comes in contact with a Nickel-Cadmium battery or its electrolyte can cause severe damage.

6.2. Make certain that cell links are secure. A loose cell link can generate heat and cause arcing which may ignite battery hydrogen gases. Torque the cell links according to the manufacturer’s specifications.

6.3. Keep battery and vents clear of obstruction by brushing with a non-metallic brush or cleaning cloth. Do not use solvents or wire. Most batteries have rather small vents, therefore it is imperative that these vents be kept clear. This of course applies to the aircraft vent lines as well. It is good practice to check vents at regular intervals.

6.4. Cleanliness of batteries is important - all manufacturers explain in detail the importance of cleanliness and leakage current checks. This highlights the need for cleaning and checking of the aircraft battery connector plug. Whenever a battery is removed this connector collects dirt and dust as it lies in the aircraft. Also the sockets lose their tension and become quite a loose fit on the battery pins.

6.5. Adjust the electrolyte level, if necessary, only after the battery has been fully charged using distilled or demineralised water. When a Nickel-Cadmium battery is in a discharged condition the electrolyte is absorbed into the plates and may not be visible from the tops of the cells. Immediately after charging the electrolyte is at its maximum height in the cell.

6.6. Evidence of electrolyte being spewed out of the battery cell vents indicates an abnormal condition which requires corrective action. Under these conditions remove the battery for bench servicing, and check the aircraft electrical system for proper bus voltage and system regulation. The time between electrolyte checks varies with the type of operation etc. It is necessary for each operator to develop his own check periods by experience. Electrolyte level should be maintained to the manufacturer’s specifications. A key point to remember is that the addition of too much water when the battery is discharged or in a partially discharged state will result in electrolyte spewing out during charging.

This can result in the following:

6.6.1. corrosive effects on the cell links;

6.6.2. creation of current leakage paths between cells and the battery case resulting in self discharge of the battery;

6.6.3. dilution of the electrolyte density which reduces battery capacity;

6.6.4. possible blockage of the cell vents by potassium carbonate residue with a resultant pressure build-up and eventual cell rupture.

6.7. A point which is often overlooked is checking the electrolyte for discoloration. Cloudy, frothing or dark electrolyte is usually a sure sign that the cell is defective. Black or brown foreign substances may also be visible and all of these faults could be attributed to contamination with acid. Therefore it is absolutely necessary to keep lead acid batteries and any associated equipment in a completely separate area from Nickel-Cadmium batteries.

7. Aircraft maintenance practices. For battery maintenance in the aircraft special attention should be given to the following areas:
   7.1. charging Nickel-Cadmium batteries with a constant voltage ground power unit is not recommended as this eventually results in cell imbalance and gradual reduction in battery capacity. Observe the following criteria when charging a battery in the aircraft:-
      7.1.1. ensure that the battery compartment is well ventilated;
      7.1.2. establish that the ground power unit voltage output is well regulated and its voltammeters are accurate;
      7.1.3. remove the battery cover and check that cell links and caps are secure. Leave the battery cover off during charging to allow visual monitoring and to increase ventilation;
      7.1.4. ensure that the charging voltage does not exceed the recommended bus voltage setting for the particular aircraft;
      7.1.5. ensure that the battery does not spew out electrolyte.
   7.2. It is not recommended that battery electrolyte specific gravity checks be performed in the aircraft. The specific gravity reading does not indicate the state of charge of a Nickel-Cadmium battery but only indicates the concentration of the potassium hydroxide in the electrolyte. Remember that if electrolyte is being boiled or spewed out of the battery there is a need for corrective action, including bench servicing of the battery.
   7.3. Visually inspect the battery and associated hardware on a periodic basis. Conduct a detailed investigation when any of the following discrepancies are noted:
      7.3.1. cell case distorted;
      7.3.2. cell link corrosion;
      7.3.3. burn marks on battery terminals or cell links;
      7.3.4. cell links show signs of overheating;
      7.3.5. electrolyte has spewed or leaked from cells;
      7.3.6. battery and cell vents are obstructed.
8. Summary. Optimum and reliable performance can be expected from Nickel-Cadmium batteries when they are operated, maintained, and overhauled in accordance with the battery and aircraft manufacturer's instructions. The degree of reliability is directly proportional to the quality of the practices followed in the operation, maintenance, and overhaul of Nickel-Cadmium batteries.