U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

AC 00-33A
DATE: 02/14/1973

AC No: 00-33A

Date: 14 Feb 73

Initiated by: AFS-350/130

Subject: NICKEL-CADMIUM BATTERY OPERATIONAL, MAINTENANCE, AND OVERHAUL PRACTICES

1. PURPOSE. This circular provides guidelines for more reliable nickel-cadmium battery operation through proper operational and maintenance practices, and has been reissued to include reconditioning information.

2. CANCELLATION. Advisory Circular 00-33, dated August 1971, is cancelled.

3. BACKGROUND. An increasing number of potentially hazardous incidents involving nickel-cadmium batteries, during flight and ground operations, have been reported. The failures are more prevalent where the batteries are charged directly from the DC bus rather than by a separate battery charger. Although the nickel-cadmium battery is capable of delivering large amounts of current, the battery is inherently temperature sensitive and a majority of the reported incidents can be attributed to overheating. The overheat conditions can be minimized or averted by following proper operational, maintenance, and overhaul practices.

4. THERMAL EFFECTS ON NICKEL-CADMIUM BATTERIES. The nickel-cadmium battery is capable of performing to its rated capacity when the ambient temperature of the battery is in the range of approximately 70 degrees to 90 degrees F. An increase or decrease in temperature, from this range, results in reduced capacity. A combination of high battery temperature (in excess of 100 degrees F) and overcharging can lead to a condition called "thermal runaway." Basically, "thermal runaway" is an uncontrollable rise in battery temperature that will ultimately destroy the battery. This condition can occur when a nickel-cadmium battery is operated at above normal temperatures and is subjected to high

charging currents associated with constant voltage charging. As the temperature of the battery increases, the effective internal resistance decreases and higher current is drawn from the constant voltage charging source. The higher current increases the battery temperature which in turn results in even higher charging currents and temperatures.

5. BATTERY OVERHEAT FACTORS. Battery overheating can be caused or accelerated by the following factors:

   a. Frequent engine starts and excessive engine cranking.

   b. Aircraft generator bus voltage too high.

   c. Improper charging and infrequent battery reconditioning.

   d. Unnecessary use of the aircraft batteries to run auxiliary equipment such as lights, avionics equipment, ventilation systems, etc. during ground operations.

   e. Poor or no ventilation of the battery compartment during high ambient temperatures particularly during ground operations.

   f. Loose cell-to-cell connections (commonly called links).

   g. Current leakage between cell and battery container and airframe ground.

   h. Cells low on electrolyte.

   i. Ground operations using power units with voltage settings higher than the recommended aircraft bus voltage, or power units with poor regulation.

   j. Cell imbalance.

6. OPERATIONAL PRACTICES TO PREVENT BATTERY OVERHEATING.

   a. Reduce the number of consecutive engine starts by programming the use of a well regulated external power supply when a series of short duration flights or consecutive engine starts are planned. This procedure will allow the battery to dissipate some of its accumulated heat. Avoid prolonged engine cranking and follow the manufacturer's recommended rest periods between starts to minimize battery over-heating.

   b. Frequent inflight monitoring of the aircraft bus voltage and load current will provide an indication of any increase, decrease or fluctuations of the aircraft bus voltage or load current indicating an abnormal condition.

   c. An increase in load or charge current as indicated on the aircraft load meter, especially during normal cruise, with no additional circuits being energized may be an indication of battery overheat or failure. Initiate corrective action as soon as possible.

7. MAINTENANCE PRACTICES TO PREVENT BATTERY OVERHEATING.

a. Service batteries at the interval recommended by the aircraft and battery manufacturer; however, more frequent servicing may be necessary depending upon the type of operation you are conducting.

b. The aircraft voltage regulator setting should be checked periodically to correct for out-of-calibration units and replacement of defective units thereby reducing the possibility of an inadvertent increase in charging voltage/current and a resultant rise in battery temperature.

c. During extended ground operation, under high outside ambient temperatures, keep the battery loads to a minimum and ensure there is adequate battery compartment ventilation. Additional ventilation may be provided by opening the battery compartment access door or using forced air ventilation.

d. Check and maintain the manufacturer's recommended torque values on intercell connections during routine maintenance inspections. This will reduce the possibility oflocalized heating that can be caused by high currents passing through poor connections and feeding back into a cell or cells.

e. Periodic measurement of battery leakage current and removal of any electrolyte that may have accumulated around and between the cells will prevent high leakage currents and short circuits from developing and heating the battery.

f. Cell electrolyte level should be monitored frequently and if below the minimum requirement the battery should be removed from service for reconditioning. This will reduce the possibility of localized cell overheating.

g. When charging a battery in the aircraft assure that:

(1) The battery compartment is well ventilated.

(2) The ground power unit voltage setting does not exceed the aircraft bus voltage specified by the aircraft manufacturer; is well regulated; and its volt/ammeters are accurate.

(3) The battery cover is off during charging to allow visual monitoring and to increase ventilation.

(4) The battery is not charged when the battery temperature or battery compartment temperature is above approximately 100 degrees F.

8. BATTERY INSPECTION. Visually inspect the battery and associated hardware on a regular basis. Depending on the type of aircraft operation, it is considered good practice to establish an electrolyte level inspection interval based on the battery and aircraft manufacturer's recommendations. Conduct a detailed investigation when any of the following conditions are noted:

a. Cell case distortion indicates the battery may have been overheating. The battery should be removed and sent to a maintenance facility or factory for cell replacement.

b. Cell link corrosion.

c. Burn marks or signs of overheating on battery terminals or cell links. This indicates that the connectors involved have not been properly tightened.

d. Electrolyte has spewed or leaked from cells.

e. Battery and cell vents are obstructed.

The use of a service log provides an accurate service record of battery inspections and malfunctions. It can also be a useful tool in determining the optimum period between reconditionings.

9. RECONDITIONING SERVICE. It is characteristic of a nickel-cadmium battery to undergo a temporary loss of capacity during its normal duty cycle. This temporary loss of capacity is normally an indication of imbalance between cells. If not regularly maintained, this imbalance can lead to cell reversal and premature battery failure. The purpose of periodic reconditioning is to restore a battery to its full capability and to prevent premature damage and failure. The following factors should be considered when establishing reconditioning cycles for various types of aircraft.

a. Battery manufacturer recommendations; for example one battery manufacturer recommends the following approximate battery reconditioning cycle periods:

	Type	Approximate Reconditioning Period
(1)	Lear 23, Jet Commander, MU-2 and Turbo Commander	100 hours
(2)	King Air, Beech 99, Fan Jet Falcon	100 hours
(3)	Hansa Jet, Twin Otter, Merlin I and IIB	100 hours

b. Frequency of engine or auxiliary power unit starting service.

c. Battery duty cycle.

d. Ambient operating temperatures.

e. Operator service experience will dictate the need for an increase or decrease of time between reconditioning periods. One method of determining this is by the amount of water consumption between reconditioning. (Each manufacturer specifies the amount of water that can be expected to be needed after a specific period of service.) If during servicing, all of the cells require more water than is normally specified by the manufacturer it may indicate problems with the aircraft voltage regulator (charging voltage too high) or you may have a need for more frequent reconditioning.

Aircraft equipped with battery temperature sensors should have the sensor accuracy tested at the time of battery reconditioning. It is important that this test be performed on a regular basis.

10. SHOP MAINTENANCE. Follow the battery manufacturer's instructions regarding periodic servicing, capacity checks, and reconditioning procedures to ensure a reliable and properly conditioned nickel-cadmium battery. The following area should be given special attention:

a. Battery facilities. Separate shops, equipment, and tools are recommended for servicing nickel-cadmium and lead-acid batteries.

b. 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.

11. OVERHAUL PRACTICES. The construction and design of nickel-cadmium batteries allows easy overhauling of the individual cells. The following guidelines are recommended to ensure meeting the original battery manufacturer's specifications.

a. It is recommended cells be overhauled only once. It is the repair facility's responsibility that repaired cells meet all manufacturer's specifications before approval for return to service.

b. Manufacturers do not recommend mixing cells. Some manufacturer's warranties are void if cells are mixed.

c. New and overhauled cells may be identified as follows:

(1) New cells by the manufacturer's part number stamped on the case.

(2) Overhauled cells with the manufacturer's or repair station's identification stamped on the cell case, or color coded on the cell cases.

(3) The original manufacturer's part number should be retained on the overhauled cell to preclude mixing of cells. Repair agencies should mark the overhauled battery with their identity mark so as to not obliterate the original manufacturer's identification.

d. In addition to the standard quality control procedures, inspect plates carefully for evidence of burned, crimped, or frayed edges, hot spots or other damages.

e. Damaged cell plates or stacks should be discarded. Nickel-cadmium cells are not consistently identical with respect to their capacity.

12. SUMMARY. Optimum and reliable performance can be expected from nickel-cadmium batteries only when they are operated, maintained, and overhauled in accordance with the battery and aircraft manufacturers' instructions. Overheating and thermal runaway are the prime causes of battery degradation and cell/battery destruction. The degree of reliability is directly proportional to the quality of the practices followed in their operation, maintenance and overhaul.

/s/ C. R. MELUGIN, JR.
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