NI-CAD BATTERY - ADJUSTMENT/TEST

1. General

A. This adjustment/test procedure is designed to provide maintenance technicians with information needed to recondition Marathon brand Ni-Cad batteries and to provide a method to check for electrical leakage.

(1) Reconditioning of batteries consists of charging, discharging, deep cycling and recharging procedures.

(a) The preferred method of reconditioning a Ni-Cad battery is to utilize a Marathon PCA-131-50/60 battery charger/analyzer.

(b) Alternate methods of reconditioning a Ni-Cad battery are also provided in this section. These alternate methods include procedures for constant current, stepped constant current, float charging and constant voltage.

2. Notes and Precautions

A. A new battery is shipped discharged and contains the proper amount of electrolyte. It does not require leveling even though the battery may appear to have insufficient electrolyte.

B. The electrolyte, which is a 30 percent solution (by weight) of potassium hydroxide in distilled water, does not take an active part in the chemical reaction. It is used only to provide a path for the current flow. At 70°F, the specific gravity of the solution should remain within the range of 1.24 to 1.30.

C. An unusual characteristic of theNi-Cad battery is that, when the battery is completely discharged, some cells will reach zero potential and charge in the reverse polarity. This action will adversely affect the battery, such that it will not retain a full capacity charge. As a result, it becomes the equivalent of a much smaller rated battery. The cure for this problem is to deep cycle the battery and short- circuit each cell to obtain a cell balance at zero potential. This process is known as equalization. Battery must be sent to an authorized battery service shop for cell equalization.

WARNING: The electrolyte used in Ni-Cad batteries is a caustic solution of potassium hydroxide. Serious burns will result if it comes in contact with any part of the body. Use rubber gloves, rubber apron and protective goggles when handling this solution. If solution gets on the skin, flush the affected area thoroughly with water, neutralize with three percent acetic acid, vinegar or lemon juice. If electrolyte gets into the eyes, flush with water. Get immediate medical attention.

D. The battery electrolyte is corrosive and should not be serviced in the airplane. Any amount of electrolyte that is expelled will react with carbon dioxide and form white crystals of potassium carbonate. The white crystals are a noncorrosive, nontoxic substance which are easily wiped away with a clean, damp cloth.

E. The battery may be charged at a temperature of less than -20°F. However, charging is more efficient at battery temperatures between +40°F and +80°F.

F. The length of time required to fully charge a battery is dependent on the condition of the battery and the method of charging.

G. The battery requires reconditioning service when the BATTERY OVERHEAT warning light illuminates. Perform a minimum reconditioning program.

H. Battery reconditioning under a maintenance inspection program or preventive maintenance requires shop inspection and testing.

I. The following characteristics apply to Ni-Cad batteries:

(1) Apparent Loss or Temporary Loss of Capacity - When this temporary loss occurs, the battery capacity will be lower than the rated capacity. This effect is more common when recharging across a constant potential bus. The loss of capacity is normally an indication of imbalance between cells because of differences in temperature, charge efficiency and self-discharge rate in the cells.

(2) Minimal Capacity Loss with Age - A loss of capacity is a warning and should not be treated lightly. The only way to accurately check the capacity (state-of- charge) is by measured discharge.

3. Tools, Equipment and Materials

A. For a list of required tools, equipment and materials, refer to Electrical Power - General.

4. Battery Reconditioning Using the Marathon PCA-131-50/60 Charger/Analyzer

A. Battery Reconditioning Procedures.

NOTE: The Marathon Model PCA-131-50/60 series charger/analyzer is designed to provide maximum service from ni-cad batteries. It features a GO/NO-GO indication of battery conditions. The correct

charge and discharge current is preselected with setting of switch position The battery can be left unattended during charge and automatically adjusts for changes in line voltages. It will automatically terminate discharge if the average battery voltage falls below a preselected end voltage. The actual discharge time can be determined from the running timer.

(1) Clean battery. Refer to Ni-Cad Battery - Cleaning/Painting.

(2) Perform electrical leak check. Refer to Electrical Leak Check in this section.

(3) Connect battery to PCA-131-50/60 charger/analyzer.

(4) Rotate SELECTOR knob to MA-5 position.

(5) Move AUTOMATIC CYCLE/MANUAL DISCHARGE switch to AUTOMATIC CYCLE position and AC POWER switch to the ON position.

(6) Rotate timer control to TOPPING position. Top charge battery until voltage reaches 30.0 VDC minimum. If battery voltage does not rise to 30.0 VDC within 30 minutes, check voltage of each cell and ensure no cells are shorted. If shorted cell is found, replace cell. Refer to Ni-Cad Battery - Removal/Installation.

(7) Check electrolyte level in cells and adjust as required. Refer to Chapter 12, Ni-Cad Battery - Servicing .

(8) Rotate timer control to DISCHARGE position.

NOTE: Battery will discharge for approximately two hours in the DISCHARGE cycle. If battery conditions are normal, the automatic cycle will continue. If discharge time is less than the 120 minutes, BATTERY LOW light will illuminate on charger/analyzer. If this occurs, set AUTOMATIC CYCLE/MANUAL DISCHARGE switch to MANUAL DISCHARGE position and continue battery discharge.

(9) Fabricate 14 shorting straps and six 1.0 ohm, two-watt resistors. Refer to Figure 501 for fabrication details.

(10) As each individual cell reaches 0.5 VDC or less, place shorting strap across both terminals while the load is applied. Ensure switch remains in MANUAL DISCHARGE position.

(11) Continue the discharge until 14 of the cells are shorted out with shorting straps.

(12) Place the 1.0 ohm, two-watt resistor across each of the remaining cells. Disconnect battery from charger/analyzer and allow shorting straps and resistors to remain attached to battery cells for a minimum of three hours.

(13) If the discharge time of step 4.A.(8) was more than 100 minutes, proceed to final charge as detailed in step 4.A.(15).

(14) If the discharge time of step 4.A.(8) was less than 100 minutes, the battery must be charged per step 4.A.(15), discharged per step 4.A.(8) through step 4.A.(12), and then charged per step 4.A.(15).

(15) Set the automatic/manual switch to AUTOMATIC CYCLE position, turn the PCA- 131-50/60 power on, and rotate the clock to the MAIN CHARGE mode. The charge will continue until both the main and topping charges are completed.

(16) During the final five minutes of the TOPPING charge (in the event the charger has turned off, reset the charger to TOPPING charge for 10 minutes), check the voltage of each cell (with charger current flowing to the battery). With the battery at room temperature (60° to 90°F), the minimum voltage should be 1.55 VDC per cell, and the maximum voltage should be 1.75 VDC per cell.

NOTE: If any cell fails to rise to a minimum of 1.55 VDC, reset the timer to TOPPING charge for one hour and recheck the voltage per step 4.A.(16).

NOTE: Any cell that fails to rise to 1.55 VDC or peaks above 1.55 VDC and then decreases below 1.50 VDC must be replaced. Any cell that has a voltage rising above 1.75 VDC should also be replaced. For battery cell replacement, refer to Ni-Cad Battery - Removal/Installation . If five or more cells are found to be defective, it is recommended that the entire battery be replaced. If the battery discharge time is less than 100 minutes after three charge/discharge cycles, it should be removed from service.

(17) If the battery has passed all the requirements of steps 4.A.(1) through (16), proceed to step (18).

(18) Recheck electrolyte level and adjust as required. Refer to Chapter 12, Ni-Cad Battery - Servicing.

(19) Torque all loose nuts and screws that attach the intercell connectors to the cell terminals. Refer to Table 501.

(20) Perform a second electrical leak check. Refer to Electrical Leak Check in this section.

(21) If the battery has passed all the preceding requirements, it is ready for installation or storage.

Table 501. Battery Cell Torque Values

Fasteners Thread Size	Socket Head Cap Screw	Torque Values
1/4”-28	3/16”	100 to 125 inch-pounds.

5. Battery Reconditioning Using Alternate Methods

A. Alternate Reconditioning Methods.

(1) Clean battery. Refer to Ni-Cad Battery - Cleaning/Painting.

(2) Preform electrical leak check. Refer to Electrical Leak Check in this section.

(3) Place battery on a constant current charger at five-hour charge rate (8.0 amps) until the battery voltage reaches a minimum of 31.0 VDC (an average of 1.55 VDC per cell). Refer to Table 502 for other charge rates.

(4) If the battery voltage does not rise to 31.0 VDC within 30 minutes, check voltage of each cell for short. Replace shorted cell(s). Refer to Ni-Cad Battery - Removal/Installation for cell replacement procedures.

(5) Check the electrolyte level. Refer to Chapter 12, Ni-Cad Battery - Servicing.

CAUTION: Do not attempt to discharge a battery at an excessively high rate and then attempt to short-circuit each cell at the end of this discharge. Batteries which have been discharged at high rates are not fully discharged. Application of shorting devices to individual cells at the end of such a high discharge will produce severe arcing and intense heat.

(6) Record the time it takes to accomplish the following:

(a) Discharge battery at a rate of one hour with a 40 amp load or two hours with a 20 amp load.

(b) Continue to discharge the battery. As each individual cell reaches 0.5 VDC or less, place a shorting strap across its terminals while still discharging battery. (Refer to Figure 501.)

(c) When 14 of the cells are shorted out with shorting straps, place a 1.0 ohm two-watt resistor across each of the remaining cells. Allow the battery to remain shorted for at least three hours. After three hours, remove the resistance load bank, shorting straps and 1.0 ohm resistors.

(7) If the discharge time recorded in step 5.A.(6) was less than 100 minutes, charge the battery per step 5.A.(3), discharge the battery per step 5.A.(6) and charge battery again per step 5.A.(3).

Table 502. Constant Current Charge Rates

Battery Type	1-Hour Charge Rate	Fast 4-Hour Charge Rate	14-Hour Charge Rate
Marathon TSP-410	40.0 Amperes for 1 hour	8.4 Amperes first 2 hours 8.4 Amperes second 2 hours	4.3 Ampers for 14 hours

(8) Recharge the battery using one of the following methods:

CAUTION: When operating at higher battery temperatures, battery is subjected to danger of thermal runaway due to overcharge. This condition is characterized by continuously increasing current and rising battery temperature during constant current charging.

CAUTION: The continual charging above gassing potential results in excess water loss due to decomposition and heat generation. At high ambient temperatures, heat loss of battery through radiation and conduction is lower than the heat-generating rate. This results in a net increase in battery temperature. This increase causes a higher charge current during constant current charge. This higher charge current further increases temperature which continues to drive off water through decomposition.

(a) Constant Current Charging - The length of time required to charge a battery by constant current charging depends on the capacity of battery and the state of charge current. In order to maintain a constant current, it should be noted that voltage of system will vary from 1.4 VDC per cell at beginning of charge to a maximum of 1.75 VDC per cell at end of charge. The constant current method employs a five hour rate. The five hour rate is arrived at by dividing five hours into 40 ampere-hours for an 8.0 ampere rate. This 8.0 ampere rate should be sustained for seven hours to provide a 140 percent charge to the battery. Constant current charging can be accomplished manually by monitoring charging the apparatus and adjusting voltage periodically to maintain a constant charged rate.

NOTE: It may not be necessary to charge battery for entire time. To determine whether battery

has reached full charge state as indicated in Figure 502 after a sharp voltage rise, it is then necessary to permit battery to charge for an additional two hours. During this two hour period, it is possible to check cell voltages and determine whether all cells are rising evenly. Should some cells indicate a voltage lower than 1.55 VDC, it is advisable to leave battery on charge until these cells come up to a minimum of 1.55 VDC.

CAUTION: Stepped constant current charging may cause a loss of water, resulting in higher concentration of electrolyte and possible battery cell damage due to overheating.

(b) Stepped Constant Current Charging - If it is necessary to obtain a rapid charge, battery may be permitted to charge at a current equal to its capacity (a 40 ampere-hour battery, for example, may be charged at a rate of 40 amperes). At this high rate, battery should be monitored and when total battery voltage averages 1.50 VDC per cell, charging rate shall be reduced to a five-hour rate (8.0 ampere) for remainder of charging cycle. At time of reduction, a conditioned battery will have completed approximately 70 percent of charge cycle if it was completely discharged to begin with. This method of charging must be monitored because the high rate will eventually use all water in battery if permitted to continue beyond gassing point.

(c) Float Charging - Fully-charged batteries may be floated across a line voltage of approximately 1.42 VDC per cell. The battery may be trickle-charged at 28.4 VDC. A battery floated in this manner will draw about 0.003 amps per ampere-hour of capacity.

NOTE: Voltage setting of 1.42 VDC will vary slightly with ambient temperature of operation.

CAUTION: When using constant voltage charging at high ambient temperatures, adjustments must be made in charging voltage to ensure that a thermal runaway condition does not exist. If battery temperature exceeds 120°F, no charging should be attempted as a thermal runaway will occur, destroying battery.

(d) Constant Voltage Charging - A voltage produced by generator permits current flow to battery. In a discharged battery, maximum surge of current will be approximately ten times rated capacity of battery. High-surge currents are due to low internal resistance of battery. Ensure charging source is protected against overload in event of a marginal power supply. Recommended voltage setting for battery charger voltage regulator is 30.0 VDC at 70°F to 80°F. Multiply recommended voltage per cell by number of cells to obtain correct voltage setting for charging from a constant voltage source. At lower temperatures, battery will accept charge if proper adjustments are made to regulating source. If voltage is not corrected, battery will not deliver its rated capacity.

(9) During final five minutes of charge (with current still flowing), measure voltage of each individual cell. Maximum voltage for each cell should be 1.55 VDC, and maximum voltage for each cell should be 1.75 VDC at room temperature (60°F to 90°F).

(10) If any cell fails to rise to at least 1.55 VDC continue current charge for an additional hour. During the final five minutes of charge, measure voltage of each cell again.

(11) If any cell fails to rise to 1.55 VDC or peaks above 1.55 VDC and then decreases below 1.50 VDC or exceeds 1.75 VDC, it must be removed from battery and replaced with another cell. Refer to Ni-Cad Battery - Removal/Installation. This will also require another battery discharge per step 5.A.(6) and charge per step 5.A.(7).

(12) After completion of the charge, check the electrolyte level again. Refer to Chapter 12, Ni-Cad Battery - Servicing.

(13) If battery discharge time recorded in step 5.A.(6) is less than 100 minutes, battery must be recharged per step 5.A.(7) and then discharged per step 5.A.(6). Record discharge time. Recharged per step 5.A.(7).

(14) If battery fails three charge/discharge cycles, it should be removed from service.

(15) Tighten loose nuts or screws that attach intercell connectors to cell terminals; refer to Table 501 for torque values.

(16) Perform electrical leak check. Refer to Electrical Leak Check.

B. If battery has passed preceding requirements, it is ready for installation or for storage.

6. Electrical Leak Check

A. Perform an electrical leak check of battery.

NOTE: Before performing electrical leak check, ensure all intercell connectors are installed and that nuts on screws attaching intercell connector to cell terminals are torqued per Table 501.

(1) Using a multimeter, set the range selector to 500 milliampere range or higher and measure the battery external leakage as follows:

CAUTION: Do not touch the multimeter negative lead to the negative terminal of the battery receptacle.

(a) Place the multimeter positive lead on the positive terminal of the battery receptacle and momentarily touch the multimeter negative lead to one of the screws that are used to mount the battery receptacle to the battery case.

1 Record the current (ampere) reading shown on the multimeter scale.

2 Remove the multimeter positive lead from the positive terminal of the battery receptacle.

(b) Place the multimeter negative lead on the negative terminal of the battery receptacle and momentarily touch the multimeter positive lead to one of the screws that is used to mount the battery receptacle to the battery case. Record the current (ampere) reading shown on the multimeter scale.

(c) If the current reading in either steps 6.A.(1)(a) or (b) exceeds 50 milliamperes, the tops of the cells shall be flushed with water and dried with clean absorbent toweling or with dry compressed air.

(d) Repeat steps 6.A.(1)(a) and (b). If the current is still greater than 50 milliamperes, one or more of the cells may be leaking. To determine which cell is leaking, measure each cell voltage as follows:

1 Using a voltmeter of 1000 ohms per volt or greater, place one of the meter leads on either the negative or positive terminal of the battery and the other meter lead on one of the screws used to mount the battery receptacle to the battery case. If the meter reads anything other than zero, there is a leak in one or more cells.

a If no leaky cells are found, the electrical leakage path may be due to electrolyte along the outside of the cells and at the bottom of the battery case. Clean the battery. Refer to Ni-Cad Battery - Cleaning/Painting.

b If a leaky cell is found, replace and perform step 6.A.(1)(d)1 and 2 again.

2 With one meter lead on one of the screws used to mount the battery receptacle to the battery case, move the other lead from one cell terminal to another in a sequential order, noting the voltage readings. Voltage readings will decrease and eventually indicate negative, disclosing location of the path and possibly a leaky cell.

a If a leaky cell is found, replace and perform step 6.A.(1)(d)1 and 2 again.

b If no leaky cells are found, the electrical leakage path may be due to electrolyte along the outside of the cells and at the bottom of the battery case. Clean the battery. Refer to Ni-Cad Battery - Cleaning/Painting.

7. Battery Receptacle Inspection

A. Items To Inspect.

(1) Connect pins should inspected for corrosion, pitting or burn marks. If any of these defects are evident to the extent that total electrical contact could be prevented, the surface should be cleaned.

(2) If cleaning process reduces pin diameter below 0.370 inch, the battery shall be replaced.

8. Battery Quick-Disconnect Inspection

A. Items To Inspect

(1) Check for excessively loose handle and locking assembly.

(2) Check for pitted or corroded mating surfaces.

(3) Check for burn marks caused when battery is disconnected under load.

(4) Test for resiliency of mating surfaces to an oversized pin (Elcon connector only). Insert larger diameter probe (0.385 inch diameter) of a GO/NO-GO gage into helix or sleeve to maximum depth. Ensure a snug fit with a removal force greater that one pound.

(5) To assure contact is adequate for a worn battery pin, insert small diameter end (0.370 inch diameter) of GO/NO-GO gage.

(a) Rebling connector, ensure each socket exerts sufficient pressure on the pin to hold the 0.370 inch diameter GO/NO-GO gage when the quick-disconnect is inverted to a position where the gage is pointed downward.

(b) Elcon connector, ensure a snug fit with a nominal removal force of one pound.

(6) If the connector fails to pass resiliency test or shows excessive wear of damage, replace connector.

Figure 501 : Sheet 1 : Shorting Strap and Resistor Fabrication

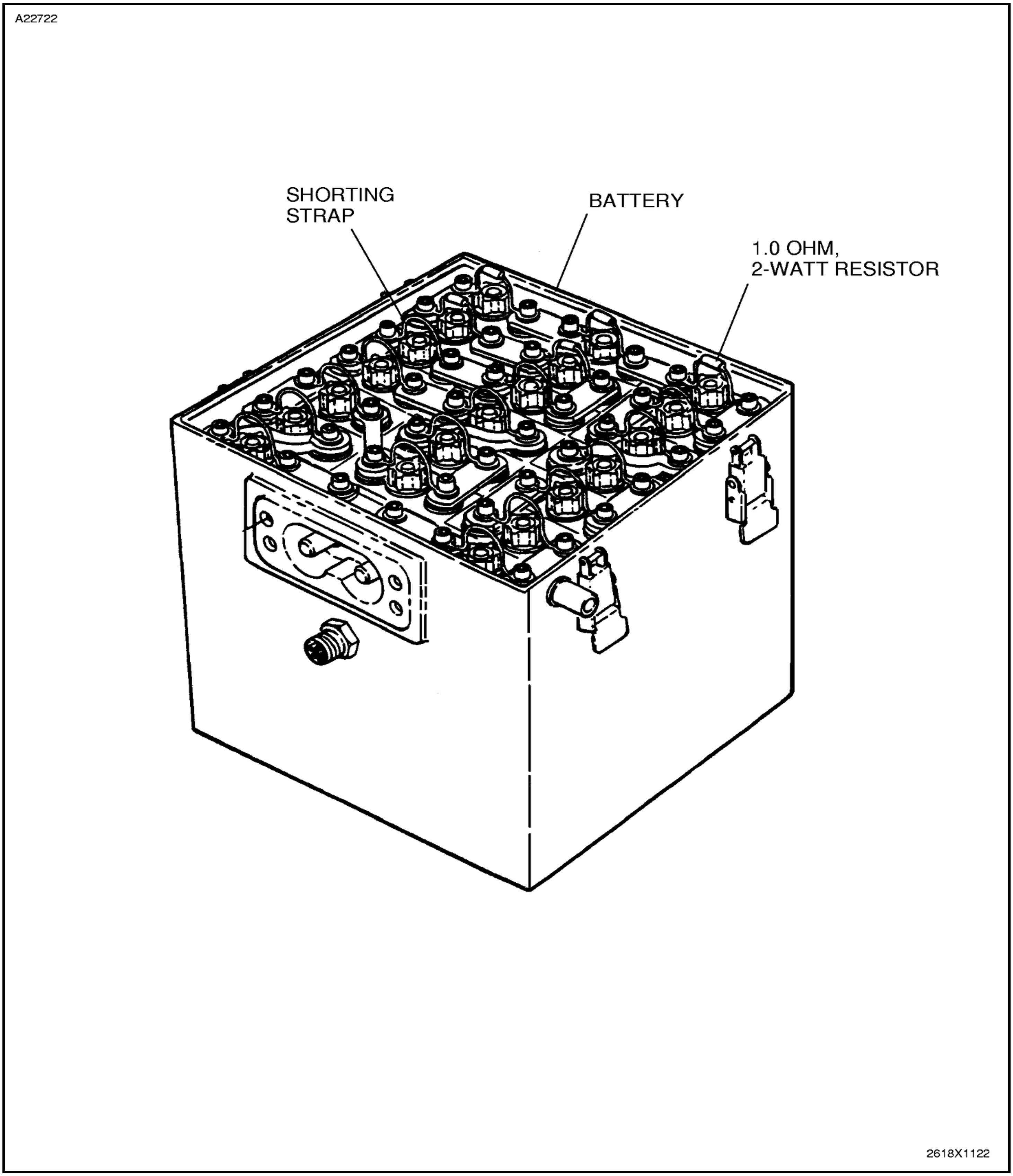

Figure 502 : Sheet 1 : Ni-Cad Battery Charging Charts

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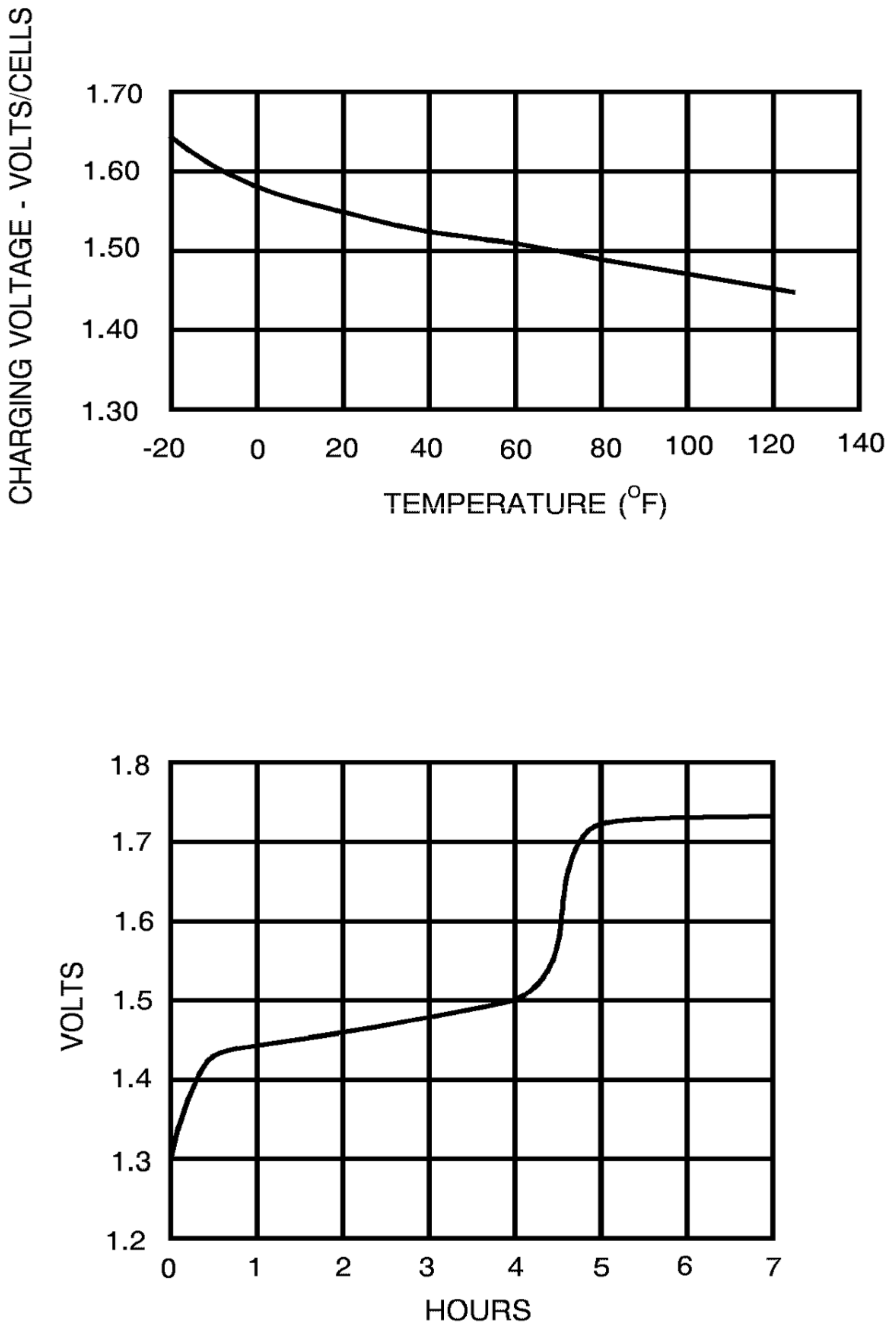

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