Operating and Maintenance Manual

For
Nickel-Cadmium
Aircraft Batteries

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INTRODUCTION

This manual contains shop verified instructions for proper installation, operation and maintenance of MarathonNorco's Nickel-Cadmium batteries. These instructions are grouped in topics shown in the Table of Contents. They are for the operation, testing, and repair of MarathonNorco's battery products.

This manual is designed to service the batteries based on the cell type within the battery. Batteries covered by this manual are listed within the INTRO section. This listing identifies the applicable cell type used within the battery to establish the servicing criteria listed in the various tables and charts within this manual.

WARNING: SERIOUS INJURY CAN RESULT FROM CARELESSNESS WHILE HANDLING AND WORKING WITH NICKEL-CADMIUM BATTERIES. PLEASE OBSERVE THE FOLLOWING SAFETY RULES WHILE WORKING WITH THESE BATTERIES.

1. Remove all metal articles such as bracelets and rings.
2. Metal tools must be insulated.
3. Wear protective clothing and eye protection. The electrolyte can cause burns if in contact with skin or eyes.
4. Do not smoke or hold naked flames near batteries on charge. These batteries give off a mixture of oxygen and hydrogen during charge, which, if allowed to accumulate in a confined space, could cause an explosion. Do not charge the battery on the bench with the cover on.
5. Do not mix lead-acid and nickel-cadmium battery servicing in the same shop area.
6. Do not use petroleum spirits, trichloroethylene or other solvents.

READ AND UNDERSTAND THE CAUTIONS AND WARNINGS STATED THROUGHOUT THIS MANUAL BEFORE PROCEEDING WITH SERVICING PROCEDURES.

CARELESSNESS MAY RESULT IN THE RAPID AND UNCONTROLLED RELEASE OF ELECTRICAL, CHEMICAL OR HEAT ENERGY.

DEFINITIONS OF COMMONLY USED BATTERY TERMS

Ampere Hours
A unit of electrical measurement used to describe the capacity of a cell or battery. The product of discharge current (in amperes) X the time of discharge (in hours). It is also used to describe the amount of electrical energy put back into a battery during the charging process. Abbreviated as Ah or Amp. hrs.

Capacity
A measure of the stored electrical energy that is available from a charged battery. Generally expressed in Ampere Hours, or as a % of the nominal (nameplate) capacity

Constant Current Charging
A method used to charge a battery in which a predetermined, fixed current is passed through it.

Constant Potential Charging (Constant Voltage)
This refers to a method in which a fixed voltage source is applied across the battery terminals. The charge current is variable and depends primarily upon the difference in voltage between the voltage source and that of the battery. The initial charge current is high and decreases as the battery accepts the charge and its voltage increases.

Trickle Charge
A continuous constant current, low-rate charge (slightly more than the self-discharge rate) suitable to maintain a battery in a fully charged condition.

Rated or Nominal Capacity
The nominal nameplate capacity rating of a nickel-cadmium battery generally refers to the number of Ampere-hours that the battery can deliver when discharged at the 1-hour rate to 1.0 volt per cell.

"C" Rate
That discharge rate, in nominal or nameplate amperes, at which a battery or cell will yield its capacity to a 1.0 volt per cell endpoint in one hour. Fractions or multiples of the C rate are also used. C/5 refers to the rate at which a battery will discharge its capacity in 5 hours. 2C is twice the C rate or that rate at which a battery will discharge its capacity in about 1/2 hour. Example: a 25 ampere-hour battery will have a C rate of 25 amperes, a C/5 rate of 5 amperes and a 2C rate of 50 amperes.

This rating system helps to compare the performance of different sizes of cells and batteries.

State of Charge
The amount of stored energy (capacity) available in a rechargeable battery. Usually expressed as a percentage of its full capacity.

Electrolyte
The conductive medium that provides for the movement of ions (current flow) between the positive and negative plates of a cell; an alkaline solution of Potassium Hydroxide in nickel-cadmium aircraft cells.

End-of-Charge Voltage
The voltage of a battery at the conclusion of a charge measured while the battery is still on charge.

Fading
The loss of capacity that occurs when a battery is cycled with minimal overcharge. A correctable condition through re-conditioning

Separator
A material that is used to prevent the metallic contact between the positive and negative plates.

Gas Barrier
A membrane in the separator system that prohibits the recombination of oxygen (produced at the positive plate) on negative plate.

Nominal Voltage (Name Plate)
The voltage of a fully charged cell or battery while delivering current. The nominal voltage of a nickel-cadmium battery cell is 1.2 volts, therefore a 20-cell battery would have a nominal voltage of 24 volts, and a 19 cell is 22.8 volts. (Note: Older batteries use a different convention for nominal voltage).

Open Circuit Voltage
The voltage of a battery at rest, that is, with no charge or discharge current flowing

Deep Discharge (Cycle)
A discharge in which most or all of the available capacity is withdrawn from a battery and the cells are brought individually to a zero volt condition.

Reconditioning
A procedure consisting of a deep discharge and a constant current charge that is used to correct cell imbalance that may occur during continual cyclic use of a rechargeable battery.

Shorting Clip
A short length of wire (with or without a low value resistor) or a metal spring, used to "short" a cell to zero volts.

MarathonNorco Aircraft Batteries

Battery Type	Cell Type	Battery Type	Cell Type	Battery Type	Cell Type	Battery Type	Cell Type
10-20H120	20H120	BB415/U	10H120	CA-154-1	15M220	CA-727-20CR	24M220CR
10-5H120	5H120	BB432/A	12M220	CA-154-2	15M220	CA-727-7	24M220CR
10-81H120	81H120	BB432A/A	12H120	CA-154-2A	15M220	CA-727-9	24H100
18-6H120	6H120	BB432B/A	12H120C	CA-154-3A	15M220	CA-737	24M220
19-10H120	10H120	BB433/A	36H120	CA-154-4	15M220	CA-9	24H120
19-24H120	24H120	BB433A/A	36H120	CA-154-5	15M220	CA-91-20	24H120
20-14M220	14M220	BB434/A	24H120C	CA-154-7	15M220	CA-9-20	24H120
20-18H120	18H120	BB476/A	10HE120	CA-16N	36H120	CA-9-20A	24H120
20-5H120	5H120	BB600A/A	36H120	CA-1700	17H100	CTCA-21H-1	20H120
23-3H120	3H120	BB641/A	10H120	CA-170A	17H100	CTSP-280	28SP100
5-81H120	81H120	BB649A/A	20H120	CA-174	17H100	CTSP-280-1	28SP100
81757/1-2	12H120	BB664/A	10HE120C	CA-176	17H100	CTSP-400	40SP100
81757/10-1	6H120	BB672/U	3H120	CA-20H	20H120	DTSP-280L	28SP100
81757/11-1	24H120	BB676/A	10H120	CA-20H-20	20H120	DTSP-400L	40SP100
81757/11-2	24H120	BB678A/A	10H120	CA-21H-1	20H120	Goalkeeper, 142D5750	20SPE100
81757/11-3	24H120	BB693/U	36H120C	CA-21H-20	20H120	GP-180	38SP100
81757/11-4	24H120	BB708/A	5H120	CA-24A	24M220CR	GSP-400	44SP100
81757/7-3	12H120	BB716/A	5H120	CA-27	24ME220(C)	GTMA-5-20	36H120
81757/8-2	24H120	BTCA-5-20	36H120	CA-27-20	24ME220(C)	GTSP-400	44SP100
81757/8-3	24H120	BTCA-9-20	24H120	CA-27-20C	24ME220C	KCA-727	24M220
81757/8-4	24H120	BTCA-9-20A	24H120	CA-31	3H120	KCA-727-20	24M220
81757/8-5	24H120	BTCA-400	40H100	CA-376	36H120	KCA-727-20C	24M220C
81757/9-2;	36H120	BTMA-5	36H120	CA-4	24M220CR	KCA-727-20CR	24M220C
81757/9-3	36H120	BTMA-5-20	36H120	CA-400	40H100	KSP-400	40SP100
ATCA-21H	20H120	BTSP-179	17SP100	CA-400A	40H100	KSP-400L	40SP100
ATCA-21H-1	20H120	BTSP-400	40SP100	CA-4-20	24M220CR	KTCA-21H-20	20H120
ATCA-21H-2	20H120	BTSP-4445L	44SP100	CA-5	36H120	MA-11	24M220CR
ATCA-21H-2H	20H120	CA-101(N)	10H120	CA-51(N)	5H120	MA-2	65H132
ATCA-441	40H100	CA-103	10H120	CA-53(N)	5H120	MA-300H	3H120
ATSP-280	28SP100	CA-106	10H120	CA-54	5H120	MA-5	36H120
ATSP-400	40SP100	CA-10N	10H120	CA-54-1	5H120	MA-500(H)	5H120
ATSP-400-2	40SP100	CA-121	12M220	CA-54-2	5H120	MA510	5H120
ATSP-44	44SP100	CA-125	3H120	CA-54-3	5H120	MA-5-20	36H120
ATSP-441	40SP100	CA-125-20	3H120	CA-54-3C	5H120	MA-5-C	36H120
ATSP-900L-1	24SP100	CA-126	3H120	CA-5H	36H120	MA-7	12M220
BA02-04	5H120	CA-13	36H120	CA-7	12M220	MA-9	24H120
BA02-05	5H120	CA-138	38H100	CA-727-20	24M220CR	PTMA-5-20	36H120
BB400	3H120	CA-139	38H100	CA-727-20C	24M220C	PTSP-400	40SP100

MarathonNorco Aircraft Batteries

Battery Type	Cell Type	Battery Type	Cell Type	Battery Type	Cell Type
PTSP-400-1	40SP100	TCA-106-3	10H120	TSP-1760L	17SP100
PTSP-440	44SP100	TCA-109L-1	10H120C	TSP-1760-L-1	17SP100
SP-138	38SP100	TCA-1069L	10H120C	TSP-25	25SP100
SP-170A	17SP100	TCA-1735	17H100	TSP-280	28SP100
SP-170AL	17SP100	TCA-1742	17H100	TSP-281	28SP100
SP-1700	17SP100	TCA-1752	17H100	TSP-283	28SP100
SP-1700L	17SP100	TCA-1753	17H100	TSP-400WB	40SP100
SP-176	17SP100	TCA-1754	17H100	TSP-400X	40SP100
SP-178	17SP100	TCA-183CH	18H120	TSP-40204B	40SP100
SP-276	24SP100	TCA-1892L	18H120	TSP-408L-1	40SP100L
SP-280	28SP100	TCA-21H-1	20H120	TSP-409L-1	40SP100L
SP-376	44SP100	TCA-21H-2	20H120	TSP-410	40SP100
SP400	40SP100	TCA-21H-20	20H120	TSP-414	44SP100
SP400L	40SP100	TCA-2492L	24M220CR	TSP-420L	40SP100
SP-401	38SP100	TCA-440	40H100	TSP434	44SP100
SP-444L	44SP100	TCA-5	36H120	TSP-440	40SP100
SP-747	38SP100	TCA-52	52H120C	TSP-4412	44SP100
SP900	24SP100	TCA-5-20	36H120	TSP-442	44SP100
SP-900A	24SP100	TCA-5-20-1(C)	36H120	TSP-44204B	44SP100
SP-910	24SP100	TCA-7	12M220	TSP-4460	44SP100
STCA-16L	36H120	TMA-4	24M220CR	TSP-4492L	44SP100
STCA-162-2	36H120	TMA-5-20	36H120	TSP-455-1	40SP100
STCA-400	40H100	TMA-5-20(c)	36H120	TSP-46-1	46SPE100
STCA-400A	40H100	TPSP-941	24SP100	TSP-900A	24SP100
STCA-420-2	40H100	TPSTSP-941	24SP100	TSP-9117A	24SP100
STCA-930A	24H100	TSP-15	15SP100	TSP-9117B	24SP100
STMA-2	65H132	TSP-1708L	17SP100	TSP-940	24SP100
STMA-5-20	36H120	TSP-1722	17SP100	TTMA-5-20C	36H120
STMA-9	24H120	TSP-1728	17SP100	UTSP-400	40SP100
STSP-400	40SP100	TSP-1735	17SP100	UTSP-440	40SP100
STSP-403	40SP100	TSP-1735L	17SP100	UTSP-460L	44SP100
STSP-444	44SP100	TSP-1742	17SP100	UTSP-460L-1	44SP100
STSP444L	44SP100	TSP-1749L	17SP100		
STSP-901	24SP100	TSP-1753	17SP100		
STSP-930	24SP100	TSP-1754	17SP100		
TCA-103C	10H120C	TSP-1755	17SP100		
TCA-106	10H120	TSP-1757	17SP100		

DESCRIPTION AND OPERATION

DESCRIPTION
General

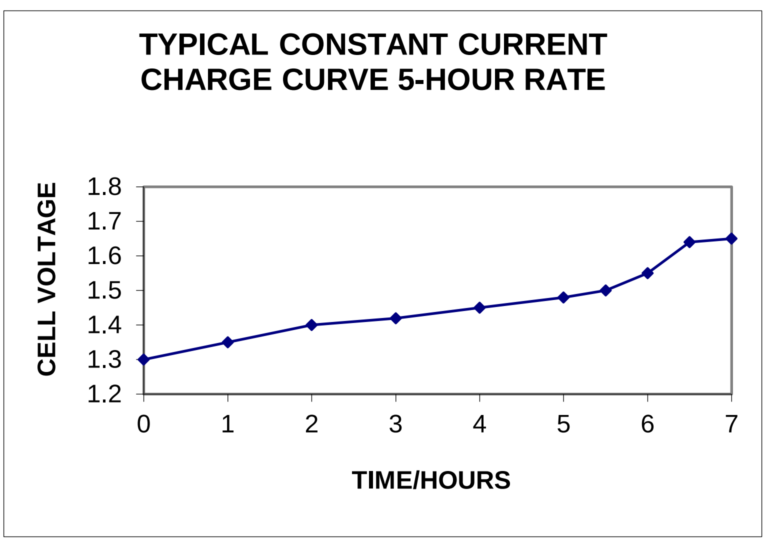
The nickel-cadmium battery cell is an electrochemical system in which the active materials contained in the plates undergo changes in oxidation state with very little change in electrolyte concentration due to the production or consumption of water. These active materials are virtually insoluble in the alkaline (potassium hydroxide) electrolyte in any oxidation state. As a result the electrodes are very long-lived.

Some of the electrochemical mechanisms involved in the charge, discharge, and storage of the nickel-cadmium battery cell are rather complex. This is especially true of the positive plate. A brief simplified account of the essential reactions is offered in order to help initiate the reader into the theory and principles of this system and thus further the understanding of the operation of the battery and the role played by its main components.

GENERAL NICKEL-CADMIUM EQUATION,

$$\underset{\text{Positive Plate}}{2Ni(OH)_2} + \underset{\text{Negative Plate}}{Cd(OH)_2} \underset{\text{dischg.}}{\overset{\text{chg.}}{\rightleftarrows}} \underset{\text{Positive Plate}}{2NiOOH} + \underset{\text{Negative Plate}}{Cd} + 2H_2O$$

FIGURE 1
Typical Constant Current Charge Curve
5-Hour Rate



Charge

Charging results in the conversion of electrical energy to stored chemical energy. The active materials, in a discharged condition, are cadmium hydroxide in the negative plates and nickel hydroxide in the positive plates. With the application of a charging current, these active materials undergo a chemical change. The negative material (Cadmium Hydroxide) gradually gains electrons and is converted to metallic cadmium (Cd); the positive material is gradually brought to a higher state of oxidation (loses electrons). As long as the charging current continues to flow through the battery, these changes will take place until the active materials in both electrodes are completely converted, at which point, overcharge commences.

Toward the end of the process (as the materials approach a full charge condition), and during overcharge, gas will be evolved and released through the cell vent. This gas results from the electrolysis of the water component of the electrolyte. The gas evolved at the negative plates is hydrogen and at the positive plates is oxygen. The amount of gas evolved depends upon the charge rate during the period in which the cells are being overcharged. After complete conversion of the active materials has occurred, the further application of charge current will only cause further electrolysis of the water and I^2R heating.

Discharge

Discharging results in the conversion of the chemical energy stored in the cell to electrical energy. During discharge, the chemical reactions which occurred in charging are reversed. The active material (Cd) in the negative plates gradually loses electrons and changes to cadmium hydroxide. The active material in the positive plates gains electrons and changes to nickel hydroxide. No gassing occurs during a normal discharge. The insolubility of the active materials and the fact that the potassium hydroxide does not participate in the cell reaction results in the very flat Ni-Cd discharge voltage curve.

The rate at which the conversions take place is primarily determined by the external resistance (load) introduced into the circuit in which the cell is connected. Due to its construction, the MarathonNorco cell has an extremely low internal resistance, and its ability to deliver high currents is due to this factor.

Charge, Discharge and overcharge equations:

Positive plate

Charge $\rightarrow$
Discharge $\leftarrow$

$2Ni(OH)_2 + 2(OH)^- \rightarrow 2Ni\ OOH + 2H_2O + 2e^-$
(Nickel Hydroxide) $\leftarrow$ (Nickel Oxy Hydroxide)

Overcharge
$4(OH)^- \rightarrow O_2 + 2H_2O + 4e^-$

Negative Plate

Charge $\rightarrow$
Discharge $\leftarrow$

$Cd(OH)_2 + 2e^- \rightarrow Cd^\circ + 2(OH)^-$
(Cadmium Hydroxide) (Cadmium)

Overcharge
$4H_2O + 4e^- \rightarrow 2H_2 + 4(OH)$

Overcharge (Net Cell Reaction)

$$2H_2O \xrightarrow{4e^-} 2H_2 + O_2$$

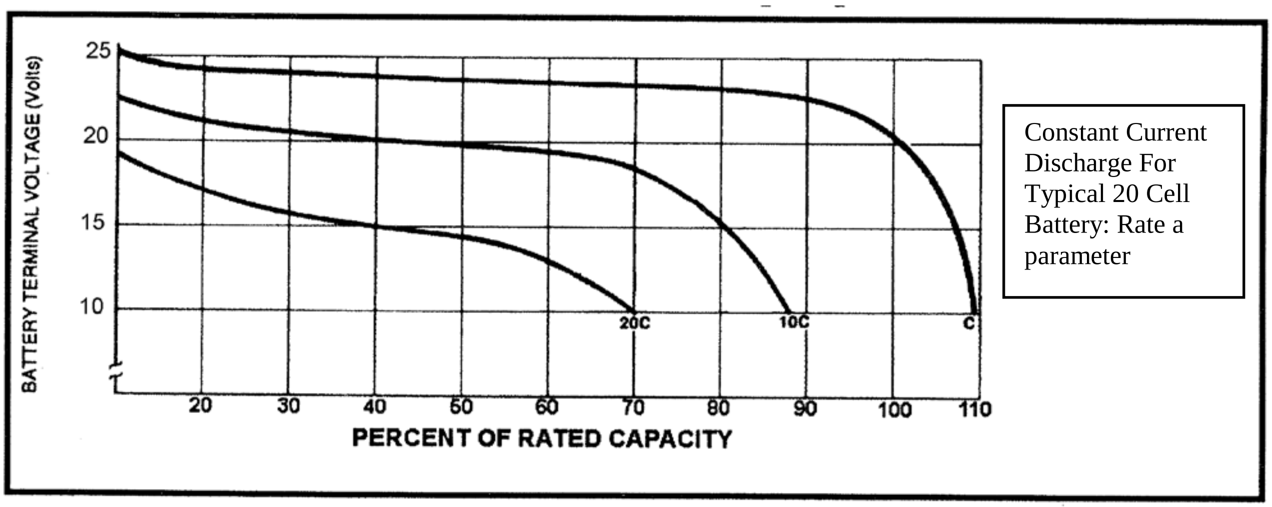


Figure 2
TYPICAL CONSTANT CURRENT DISCHARGE CURVES

Capacity

Capacity is measured quantitatively in ampere-hours delivered at a specified discharge rate to a specified cut-off voltage at room temperature. The cut-off voltage is 1.0 volt per cell.

Battery available capacity depends upon several factors including such items as:

1. Cell design (cell geometry, plate thickness, hardware, and terminal design govern performance under specific usage conditions of temperature, discharge rate, etc.).

2. Discharge rate (high current rates yield less capacity than low rates).

3. Temperature (capacity and voltage levels decrease as battery temperature moves away from the 60°F (16°C) to 90°F (32°C) range toward the high and low extremes).

4. Charge rate (higher charge rates generally yield greater capacity).

1.0 INSPECTION

1.1 Delivery Inspection

When the battery is unpacked, a thorough inspection should be made to ensure that no damage occurred during shipment. Inspect the shipping container as well as the battery. Before putting the battery into service, check the following points carefully.

1.1.1 Damage

See if any liquid has spilled into the shipping container. This may be a sign of a damaged cell. Check for dented battery container. **Check for cracked cell cases or covers. Do not place a damaged battery into service. Report any signs of improper handling to the shipping company**.

1.1.2 Shorting straps

Some batteries are shipped with shorting devices across the main power receptacle output terminals. Before subjecting battery to electrical service this device must be removed

1.1.3 Electrical connections

Test all terminal hardware to ensure tightness. If necessary re-torque them to the proper value. Poor electrical contact between mating surfaces may reduce discharge voltage, cause local overheating and damage the battery.

1.14 Liquid level - Do not add water to a battery except near the end of a constant current charge. Some exceptions may be noted later.

Addition of water, except at the proper time during the charge will cause spewing of electrolyte to take place during the subsequent charge. MarathonNorco batteries are shipped with the proper amounts of electrolyte. When a battery has been discharged or allowed to stand for a long period of time, the electrolyte becomes absorbed into the plates. Since the battery has been shipped in a discharged condition, the liquid level of the cells may appear to be low. Charging the battery will cause the liquid level of the individual cells to rise to the proper operating level. If this does not happen, add sufficient distilled or demineralized water (using the proper syringe and nozzle) to the cells during the last 15 minutes of the topping charge, until the correct liquid level is reached.

BEFORE CHARGING THE BATTERY READ AND BECOME FAMILIAR WITH THE CHARGE PROCEDURE.

WARNING: THE ELECTOLYTE USED IN NICKEL-CADMIUM BATTERIES IS A STRONG CAUSTIC SOLUTION OF POTASSIUM HYDROXIDE. USE RUBBER GLOVES, AN APRON AND A FACE SHIELD WHEN REPAIRING OR SERVICING THE BATTERY. IF ELECTROLYTE IS SPILLED OR SPRAYED ON CLOTHING OR OTHER MATERIALS, IT SHOULD BE BATHED IMMEDIATELY WITH LARGE QUANTITIES OF WATER NEUTRALIZED WITH A WEAK ACID SOLUTION SUCH AS VINEGAR. IF ELECTROLYTE GETS INTO THE EYES, FLUSH COPIOUSLY WITH WATER AND GET MEDICAL ATTENTION IMMEDIATELY.

1.2 INSPECTION IN THE AIRCRAFT

1.2.1 Vent Lines

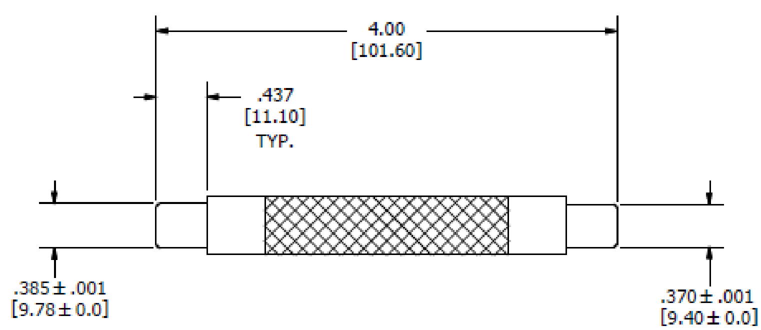
When installing a battery in the aircraft, check the vent lines for obstructions, leaks or damage of any kind and repair or replace. Check battery box vents for obstructions or cracks and repair.

1.2.1 Battery Disconnect

The following procedure defines an inspection program to field check the aircraft battery quick disconnect.

1.2.2 Equipment Required

Quick disconnect inspection gauge



INSPECTION GAUGE
FIGURE 3

1.2.3 Procedure

Inspection of Battery Quick Disconnect: Remove all electrical loads from the battery then disengage the battery disconnect from the mating receptacle, and inspect for the following:

A. Evidence of corrosion or pitting of the power contacts.

B. Excessive free-play in the hand wheel- worn assembly, broken pins.

C. Evidence of arcing of burn marks on the power contacts. This is caused when the disconnect is removed under electrical load.

D. Insert the .385 inch diameter end of the inspection gauge into each power contact to a depth of .437 inches. The fit shall be snug with a force to remove greater than one (1) pound. This is to test the resiliency of the power contact to an oversized pin**.**

E. Insert the .370 inch diameter end of the inspection gauge into each power contact to a depth of .437 inches. The fit shall also be snug with a nominal force to remove one (1) pound. This will ensure proper contact to a worn or undersized contact pin.

F. Replace if required.

1.2.4 Voltage Regulator

The voltage regulator should be set at a level consistent with the normal ambient temperature band and should be set on the aircraft after a start and a few minutes into the charging period (seeTable 1). Periodic checks to correct out- of-tolerance regulators and replacement of defective units will reduce the possibility of inadvertent increases in charging voltage with the resultant rise in charge current and battery temperature and water consumption.

Recommended voltage settings measured at the battery terminals and applicable to room temperature conditions, under a known time span of 4 hours are shown in Table 1. (These are nominal values computed by multiplying the number of cells in the battery by a factor of approximately 1.5). For voltage regulation at ambient temperature higher or lower than 75°F (24° C), see Figure 3.

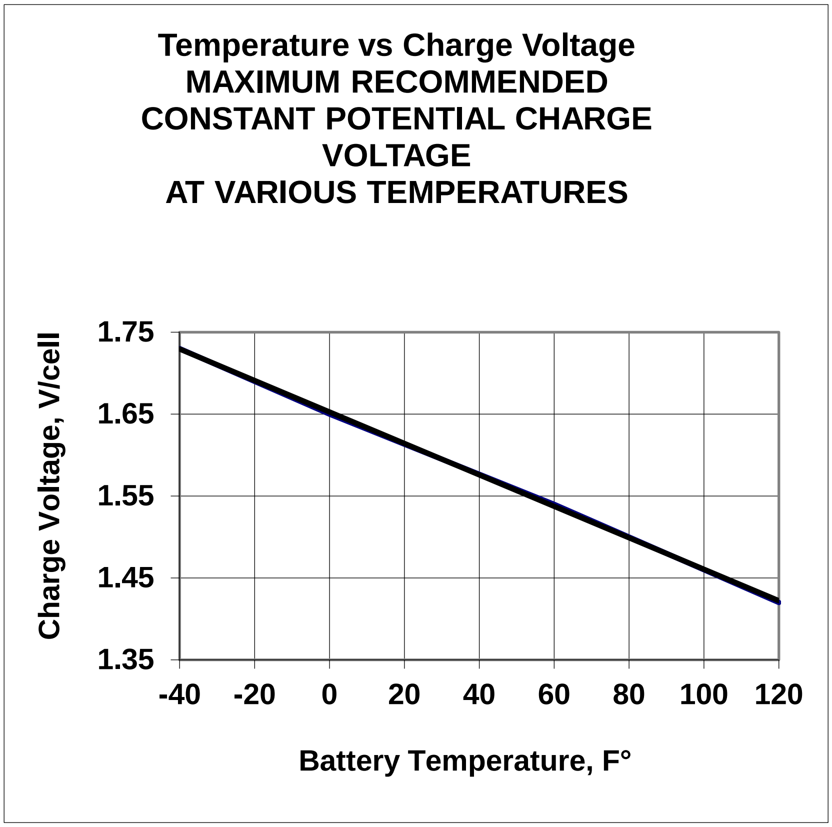
Table 1 - Recommended Voltage Regulator Setting at 75°F (24°C)

Number of Cells	Nominal Battery Voltage	Time In Hours	Voltage	Maximum* Voltage Regulator Setting
5	6	2-4	7.5-7.75	7.50
10	12	2-4	15.0-15.5	15.00
12	15	2-4	18.0-18.5	18.00
19	22.8	2-4	28.0-29.0	28.50
20	24	2-4	28.5-30.0	30.00
22	26.0	2-4	31.0-33.5	33.00

*** Constant potential charging voltage and time apply to all ampere-hour ratings, subject only to number of cells per battery**

Figure 4

Temperature vs. Charge Voltage Relationship
MAXIMUM RECOMMENDED CONSTANT POTENTIAL CELL CHARGE VOLTAGE AT VARIOUS TEMPERATURES



1.3 Inspection - Received in for Service

When a battery is received in the shop for routine servicing, the following inspections should be performed:
Visually inspect can and cover for dents, damage, epoxy coating separation, vent tube obstruction, latch function and cover seal condition.

Any evidence of discrepancies, in above shall be cause for replacement of the parts.

Remove the battery cover and inspect for the following:
Clean top of cells and connectors with a nylon brush. Blow out residue with oil-free compressed air using standard safety precautions. If cells are exceptionally dirty, connecting links, hardware, and cells may need to be removed, washed in warm water and dried. If this is required, discharge the battery before disassembly.

Verify that the polarity of the cells and position of the internal connections are correct.

Inspect intercell connectors for corrosion, burns or discoloration. Clean with an eraser or replace as required.

Remove vent plugs and inspect “O” rings and vent sleeves for damage or hardening. Replace if defective. If necessary, wash vent plugs in warm water to remove the white powder (potassium carbonate) from vent holes. Dry with oil-free compressed air using standard safety precautions.

1.3.1 Inspection of Battery Power Connector

Inspect for corrosion or pitting on the contact pins.

Inspect for arcing or burn marks on the contact pins. This is caused when the disconnect is removed under electrical load.

Inspect for battery electrolyte leakage through the receptacle body and/or the contact pins.

NOTE: Electrolyte leakage can be noticed by a discoloration of the receptacle body with the glass fibers exposed.

Gauge each contact pin diameter using dial calipers that are capable of reading to .001 inch. The diameter shall be .375 ± .005 inches.

1.3.2 Inspection of Sensor Receptacle (if so equipped)

Examine sensor connector for pin or locking mechanism damage.

CAUTION: The electrolyte used in the battery is a caustic solution of Potassium Hydroxide. Avoid contact with any part of the body.

2.0 ELECTRICAL LEAKAGE

To determine if external leakage is of such a magnitude as to require a complete battery cleaning set the range selector of a multimeter to the 500 milliampere range or higher.

Place the positive lead of the meter on the positive terminal of the battery receptacle and touch the negative lead of the meter to any exposed metal on the battery can.

NOTE: Many MarathonNorco batteries are supplied with epoxy coated battery cans and covers. Where epoxy coated cans are used, current flow may be measured between the battery terminals and the screws that are used to mount the main connector.

If the measurement is within the meter limits, connect the negative lead of the meter to the battery can. Record this current value.

Repeat the above, connecting the negative lead of the meter on the negative terminal of the battery receptacle and the positive meter lead to any exposed metal on the battery can.

If the above current measurements exceed 50 milliamperes, flush the tops of the cells and dry. (Reference Paragraph 9.0)

Repeat the above current test on the positive and negative terminals. If the tops of the cells were cleaned properly and the current measurement is still greater than 50 milliamperes, one or more of the cells may be leaking. To isolate this cell or cells, proceed as follows:

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 lead on any exposed metal of the battery can; note the meter reading. If the meter reads negative, reverse the positions of the meter leads.

Keep one-meter lead on the exposed metal surface of the can and move the other lead systematically from one cell terminal to another, noting the voltage readings. Voltage readings will decrease and finally go negative indicating the location of the path and possibly a leaky cell.

If the cell is leaking, replace the cell or cells. If no leaking cells are found, the leakage path may be due to electrolyte along the outside of the cells and at the bottom of the battery can, and the battery must be discharged, disassembled and cleaned. (Reference Paragraph 9.0 and 11.0)

3.0 TORQUING REQUIREMENTS

Verify torque on every intercell connection starting with cell 1 and working sequentially through the last cell. Verify torque on cell connections to main battery connector.

TABLE 2

BATTERY OR CELL TYPE	THREAD SIZE	SOCKET HEAD CAP SCREW	TORX SCREW	HEX NUT ACROSS FLATS	TORQUE (INCH LBS.) TO TIGHTEN
3H120	#10-32			5/16”	15-18
5H120	#10-32			5/16”	15-18
10H120	5/16”-24			1/2”	20-25
10HE120	#8-32	9/64”			30-35
12M220	5/16”-24			1/2”	20-25
12H120	#8-32	9/64”			30-35
14M220	#8-32	9/64”			30-35
15M220	#8-32	9/64”			30-35
15SP100	#8-32	9/64”			30-35
17H100	#10-32	5/32”			35-50
17SP100	#10-32	5/32”	T-25		35-50
18H120	#10-32	5/32”	T-25		30-35
20H120	#10-32	5/32”			35-50
20SPE100	#10-32	5/32”			35-50
24M220CR	#10-32	5/32”			35-50
24ME220C	#10-32	5/32”			35-50
24H120	#10-32	5/32”			35-50
24H100	#10-32	5/32”			35-50
24SP100	#10-32	5/32”	T-25		35-50
25SP100	#10-32	5/32”			35-50
28SP100	1/4”-28	3/16”	T-30		100-125
36M220	#10-32	5/32”			35-50
36H120	#10-32	5/32”			35-50
38H100	1/4”-28	3/16”	T-30		100-125
38SP100	1/4”-28	3/16”	T-30		100-125
40SP100	1/4”-28	3/16”	T-30		100-125
40SP100L	1/4”-28	3/16”	T-30		100-125
44SP100	1/4”-28	3/16”	T-30		100-125
44SP100L	1/4”-28	3/16”	T-30		100-125
46SPE100	1/4”-28	3/16”	T-30		100-125
52H120C	1/4”-28	3/16”	T-30		100-125
65H132	1/4”-28	3/16”	T-30		100-125
81H120	1/4”-28	3/16”	T-30		100-125

All other hardware should be torqued in accordance with FAA document AC.43.13 (Aircraft Inspection and Repair)

4.0 SENSOR ASSEMBLY INSPECTION

Inspect battery for proper placement of thermostats, heaters, thermistors or other sensor elements.

Inspect wiring and receptacle for insulation damage, corrosion, and crimping or other defects.

At least once each calendar year, perform a functional test on the temperature sensor assembly. All functions must be within ± 10% of the values given in Table 3.

Dielectric Test: (If required in Table 3) Use a Dielectric (Hi-Pot) Tester capable of measuring a current flow of 25 µA at 500 Volts DC. Place sensor leads in a small container filled with DI water, allowing the assemblies to be submerged completely. Place the Negative (-) lead of the Dielectric tester in the container with the sensor leads. While holding the receptacle, probe the pins listed in Table 3 with the Positive (+) lead of the Dielectric tester to check for current leakage. A current flow greater than 25 µA would constitute a failure.

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Table 3 (Page 1 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
28900-001	MS-3114P8-4P PT07P8-4P	A-B Blue C-D Red	Close at 140°F Close at 160°F	TCA-5 TCA-5-20-1 TCA-5C TCA-5-20-1C
28900-002	PT07P-8-4P MS-3114P8-4P	A-B Blue C-D Red	Close at 140°F Close at 160°F	TCA-21-H-20, TCA-21H-1
28900-003	MS-3114P8-4P PT07P8-4P	A-B Blue C-D Red	Close at 140°F Close at 160°F	TSP-400-1, TSP-400
28900-005	MS-3114P10-6P PT07P10-6P	A-B Blue C-D Red E-F	Close at 140°F Close at 160°F 1K Ohms at 77°F	TSP-455
28900-006	MS-3114P10-6P PT07P10-6S	A-Link Blue B Link Blue C-Link Red D-Link Red E-F	Close at 140°F Close at 140°F Close at 160°F Close at 160°F 1K Ohms at 77°F	TSP-455-1, TSP-2860, TSP-4460
29084-001	PT07P-8-3P	A-B B-C	49.9K Ohms Fixed Resistance 300K Ohms at 77°F	STCA-16L
29084-004	PT07P-8-3P	A-B B-C	49.9K Ohms Fixed Resistance 300K Ohms at 77°F	STCA-16L-2, TSP-420L, STMA-5-20, GP-180, STSP-400, STSP-444L, STSP-403, STSP-444
29084-005	PT07P-8-3P	A-B B-C	49.9K Ohms Fixed Resistance 300K Ohms at 77°F	TSTSP-940, STCA-910, STCA-930, STMA-9, STCA-930A, STSP-901, STMA-9C, STSP-930, TPSTP-941, STSP-902L, TSTCA-94
29084-006	Bendix PT07P-8-3P	A-B B-C	49.9K Ohms Fixed Resistance 300K Ohms at 77°F	STMA-2
29084-007	Bendix PT07P-8-3P	A-B B-C	49.9K Ohms Fixed Resistance 300K Ohms at 77°F	STSP-280

Table 3 (Page 2 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
29090-001 Superseded by 29529-001	MS-3102R-14S-6P	A-C D-F A-B D-E	195 Ohms 195 Ohms 25,000-35,000 Ohms 25,000-35,000 Ohms	BTMA-5
29170-001	M4S-LRN	A/Yellow wire-conn link C/Red wire-conn link	Close at 148°F Close at 168°F	TCA-106
29170-003	M4S-LRN	A/Yellow wire-Conn link C/Red Wire –Conn link	Close at 148°F Close at 168°F	TCA-1754 TSP-1754
29283-001	Cannon DFXB-8-34P	1 or-2 & 7 or 8 1 & 2 or 5 7 & 8 or 5	Battery Voltage 23.4K Ohms 6.90-8.0 K Ohms	CA-154-3A
29376-001	CA 3102E24-12SB	D-Link Yellow B-Link Red A C	Closes at 140°F Closes at 160°F Battery Positive Battery Negative	TCA-106-2 TCA-106-3
29376-005	Cannon Type 3102E24-125B	A-C B/Red wire-conn link D/Yellow wire-conn link	Battery Power A Positive C Negative Close at 160°F Close at 140°F	TCA-1753 TSP-1753
29376-007	Cannon Type 3102E24-125B	A-C B/Red wire-conn Link D/Yellow wire-conn link	Battery Power A Positive C Negative Close at 160°F Close at 140°F	TSP-1755
29432-003	MS-3114P10-6P	A-B Blue C-D Yellow	Close at 145°F Close at 145°F	CA-170A, CTMA-5-20C, SP-170A, SP-170AL CA-170 TMA-5-20, TMA-5-20C, TMA- 5-20CXTSP-400X, TSP-419L, TSP-40204B, TSP-44204B
29432-004	MS-3114P10-6P	A-B Brown C-D White	Close at 160°F Close at 145°F	TSP-410
29432-005	MS-3114E10-6P	A-B Green C-D Orange	Open at 160°F Open at 140°F	TSP-410, TSP-925A TSP-4410L
29432-006	MS-3114P10-6P	A-B Blue C-D Yellow	Open at 160°F Open at 140°F	TSP-210
29432-007	D38999/24WB5PN	A-B Blue C-D Yellow	Close at 160°F Close at 147°F	TSP-2840

Table 3 (Page 3 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Number	Connector Type	Active Pins		Action	Battery Type
29432-008	CANNON KPSE07E10-6P	A-B C-D	Yellow Blue	Close at 135°F Close at 160°F	TSP-280 TSP-381L
29432-009	MS-3114E10-6P	C B D E	Green White Yellow Black	28 VDC B (Test) to A (Ground) Close at 158°F D (Test) to F (Ground) Close at 140°F 28 VDC	TSP-9117B TSP-9117BL
29432-010	MS-3114P10-6P	B-C E-F	Blue Yellow	Closes at 145°F Closes at 145°F	TSP-1722 TSP-1722L
29432-011	CANNON KPSE07E10-6-P	A-B C-D E-F	Blue Yellow Green	Close at 160°F Close at 160°F Open at 160°F	TSP-283
29432-012	MS3114E8-3P	A-C B-C	Blue/Black Yellow/Black	Close at 140°F Open at 160°F	TSP-281 TSP-414
29432-015	MS3114E10-6P	A-B C-D	Blue Yellow	Close at 145°F Close at 160°F	TSP-1728
29432-016	MS3114P10-6P	A-B C-D	Blue Yellow	Close at 145°F Close at 160°F	TCA-1028
29432-017	MS-3114E10-6P	A-B C-D E-F	Blue Yellow Green	Close at 160°F Close at 160°F Close at 145°F	TTMA-5-20C
29432-018	MS-27474E10B-35P	1-3 5-2 4-6	 White Red	28VDC Close at 158°F Close at 140°F	TSP-9117A
29432-019	MS3124E10-6P	A-B C- D-E F	 Blue Green 	3K Ohms C-Ground 4.99K Ohms Fixed Close at 160°F Not used	TSP-440LF
29432-020	MS3114P10-6P	A-B C-D	Blue Yellow	Close at 145°F Close at 145°F	TCA-103C
29432-022	MS 3114E10-6P	A-B C-D E-F		Close at 145°F Close at 145°F Open at 145°F	TSP-1727

Table 3 (Page 4 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
29432-029	MIL-C-38999	1-2 3-4	30K Ohms @ Room Temp Open @ Room Temp / Close @160°F	TSP-15
29432-030	MIL-C-38999	1-2 3-4	30K Ohms @ Room Temp Open @ Room Temp / Close @160°F	TSP-25
29529-001/-002	MS3102R-14S-6P	A-C B-C D-F E-F	Heater Element-appx. 100 Ohms 36K Ohms at 70°F Heater element-appx. 100 Ohms 36K Ohms at 70°F	BTSP-179, BTCA-5, BTCA-5-20, BTSP-280, BTCA-400, BTC-5-20C, BTCA-7, BTSP-444, BTMA-5, BTSP-179, BTMA-5-20, BTSP-400, BTSP-400L
29529-003	MS3102-14S-6P	B-C E-F B, C, E, F	36K Ohms at 70°F 36K Ohms at 70°F Dielectric Test (pg.401)	BTSP-4445L
29565-002	MS3474L-8-33P	A-B	Close at 145°F	CA-376
29565-003	MS-3474L-8-33P	A-B	Close at 145°F	SP-376, SP-376L
29565-004	MS3474L-8-33P	A-B	Close at 135°F	SP-276
29573-001	PT07P-8-3P	A-B	200 Ohms at 140°F	ATCA-21H, ATSP-280-1
29685-001	MS24265R10B5P	1-2 4-5	Close at 120°F Close at 90°F	KTCA-747
29783-001	KPT07P8-4P	A-B C D	200 Ohms at 140°F Not used Not used	ATCA-21H-1
29783-002	KPT07P8-4P	A-B C-D	200 Ohms at 140°F 200 Ohms at 140°F	ATCA-21H-2
29783-003	KPT07P8-4P	A-B C-D	166.4 Ohms at 70°F 166.4 Ohms at 70°F	ATSP-400, ATSP-400-2, ATSP-44, ATSP-44L, ATSP-400L, ATSP-380
29783-004	M3-3474L8-33P	A-B	200 Ohms at 140°F	ATSP900L-1
29817-003	MS-3474W12-10SN	A Red C Yellow D-E Orange F White E-G Orange J Black	Battery Positive Battery Positive through 1K Ohms Close at 140ºF Battery Cell Balance Tap (1-9, 10-19) Close at 140ºF Battery Negative	TMA-4

Table 3 (Page 5 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
30320-001	Bendix PTS06DRL10-6S	A-B A-C	Close at 160°F Close at 160°F	TCA-14, TSP-380, TSP-440
30400-001	31279-001	1-3	Close at 160°F	TCA-1735, TSP-1735, TSP-1735L
30465-002	MS-3114P10-6P	B – Connector D – Connector	N.O. Closes 140°F N.O. Closes 160°F	TSP-1757
30727-001	PT07P-8-4P	A-D A-C	Two Thermostats in Parallel Close at 140°F	TCA-21H-2
30920-001	MS-3474L10-6PN	A-C White D-F Yellow	Close at 158°F Close at 158°F	TSP-963A
30920-002	MS-24265R10B5P	1-2	Close at 147°F	TSP-900A, TCA-900A
30920-003	MS-3114-E-10-6P	A-B White C-D Yellow	Close at 135°F Close at 158°F	STCA-940A, TCA-940A, TSP-940, TSP-940A, TSTCA-94, TSTSP-940
30920-004	PT07P-8-4P	A-B White C-D Yellow	Close at 140°F Open at 158°F	TSP-900AT L-39
30920-008	PT07P-8-4P	A-B White C-D Blue	Close at 140°F Close at 158°F	L-59
30921-001	MS-3474L10-6PN	A-C White D-F Yellow	Close at 158°F Close at 158°F	TSP-463
30921-002	MS-3474L10-6PN	A-B Yellow C-D White	Close at 135°F Close at 158°F	SP-288
30921-003	MS-27468P9A8P	A-C	2 Thermostats in Parallel Close at 160°F	CTSP-400 CTSP-280 CTSP-440
30921-004	MS-27468P9A98P	A-C	Two Thermostats in Parallel Close at 160°F	CTCA-21H-1
30921-005	MS-3124E10-6P	C-D	Close at160°F	CTSP-280-1
30921-006	MS-3114E10-6P	C-D	Close at 160°F	TSP-4412
30937-001	48-13R10-5P	1-2 Black 3-4 White	Close at 135°F Close at 35°F	SP-747

Table 3 (Page 6 of 8)

TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
31023-001	MS-27474T10-F-5S	A Orange B-C White	Voltage-mid tap to battery 3K Ohms at 68°F	UTSP-400, UTSP-460L TSP-1760L
31023-002	JT07RP105S (MS2747410F-5S)	A Orange B-C White	Voltage mid-tap to battery 3 K Ohms at 77°F	UTSP-460L
31023-003	JT07RP105S (MS27474T10F-5S)	A Orange B-C White	Voltage mid-tap to battery 3 K Ohms at 77°F	TSP-1760L
31023-005	JT07RP105S (MS27474T10F-5S)	A Orange B-C White	5 K Ohms to mid-tap of battery 3 K Ohms at 77°F	UTSP-460L-1
31023-006	JT07RP105S (MS27474T10F-5S)	A Orange B-C White	5 K Ohms to mid-tap of battery 3 K Ohms at 77°F	TSP-1760L-1
31029-001	M83723 73R1212N	4-6 Yellow 8-9 Yellow 11-12 White	Interlock Open at 154°F 2252 Ohms at 77°F	GTSP-400
31044-001	M83723/73R1212N	1 Red 2-4 White 7 Yellow 9-11 Green 12 Black	Pos. Battery voltage 3K Ohms at 77°F Center voltage tap Close at 145°F Neg. Battery voltage	TSP-464L TSP-467L
31374-001	MS-3114P-8-4P	A-B C-D	200 Ohms at 140°F 200 Ohms at 140°F	ATSP-280 ATSP-280L
31581-001	MS-3114P14-5P	A-B Black C-D Red C-E Red	Closes at 160°F Closes at 160°F Closes at 160°F	PTMA-5-20
31581-002	MS-3114P14-5P	A-B Black C-D Red C-E Red	Close at 160°F Close at 160°F Close at 160°F	PTSP-400 PTSP-400-1
31628-001	MS-3102-14S-6P	A Black C-D Black E-F White	Mid-Tap Battery Open at 158°F 2.2 → 2.3K Ohms	TSP-400WB

Table 3 (Page 7 of 8)

TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
31810-001	MS-3102R-14S-6P	A-C B-C D-F E-F	Heater Element-appx. 100 Ohms 36K Ohms at 70°F Heater element-appx. 100 Ohms 36K Ohms at 70°F	BTCA-9-20A
31851-001	MS3114P12-8P	C-E Red-Black G-+ White/Blue	10.45V to 10.61V @ 25°C1K Ohms @25°C	TCA-52
31920-002	MS-3474W106P	C-D Green	Close at 158°F	DTSP-400L, DTSP-448L DTSP-280L
32072-001	PT07P8-4P	A-B Black C-D Red	Close at 140°F Close at 158°F	TSP-447
32075-001	PT07P8-4P	A-B Black C-D Red	Close at 140°F Close at 158°F	TSP-177
32140-001	MS-3114E10-6P	A-B C-D	300K Ohms at 77°F Close at 160°F	TCA1742 TSP-1742
32140-002	MS-3114E10-6P	A-B C-D	300K Ohms at 77°F Close at 160°F	TSP-442
32288-001	MS-3114E10-6P	A-B C-D E-F	Close at 135°F Close at 160°F 91 Ohms at 32°F	TSP-434
32470-001	MS-3114P8-4P	A-C Black B-D White	Close at 160°F 100 Ohms at 32°F Pin Combination Check Open all Pins Except B-D	TSP-408L TSP-408-L-1
32470-002	MS-3114P8-4P	A-C Black B-D White	Close at 160°F 100 Ohms at 0°C	TSP-1708L
32532-001	D38999/24FA98SN	A-B	Close at 160°F	TSP-4492L
32532-002	D38999/24FA98SN	A-B	Close at 160°F	TCA-1892L
32704-001	MS24264R12B-12SN	1 8-9 11-12	Interlock Close at 155ºF 2252 Ohms at 77°F	TSP-46-1
32819-001	D38999/24FA98SN	A-B	Close at 160°F	TCA 2492L
32899-001	MS3114-P8-4P	A-B White C-A Black	Close at 160°F Close at 160°F	TSP-409L-1
32899-002	MS3114-P8-4P	A-B White C-A Black	Close at 160°F Close at 160°F	TCA-109L-1 TCA-1069L

Table 3 (Page 8 of 8)
TEMPERATURE SENSOR ASSY. SPEC

Part Number	Connector Type	Active Pins	Action	Battery Type
32899-005	MS3114-P8-4P	A-B White A-C Black	Close at 160°F Close at 160°F	TSP-1749L
33295-001	MS3114-E12-8P	A-B Blue A-C Yellow D-Connector (w/Tube) E-F White G-H Black	Close at 160ºF Open at 160ºF 1,000 Ohms at 77ºF 400 Ohms at 77ºF Close at 39ºF 5.2 Ohms when closed (See separate SIL for in situ test)	PTSP-440

5.0 CHARGE (CONSTANT CURRENT)

For batteries that are partially discharged, i.e., batteries received in for service, begin with STEP I

For batteries that are completely discharged, i.e., new batteries or batteries following deep cycle, begin with STEP IA.

CELL VENTS SHOULD BE UNLOCKED DURING CHARGE.

STEP I Connect battery to charging source and charge at the main charge rate until ***all*** cells are 1.55 volts or greater. This usually takes a short period of time.

IF CELL(S) ARE DRY, HIGH CELL VOLTAGE MAY OCCUR (1.85 VOLTS OR GREATER). FIVE TO TEN CC's OF DISTILLED OR DEMINERALIZED WATER MAY BE ADDED TO EACH CELL.

When all cells are at 1.55 volts minimum, reduce charge current to the topping charge rate and top charge for one hour. Adjust electrolyte during the final 15 minutes of the topping charge in accordance with Paragraph 6.0. Upon completion of the topping charge, while still on charge, all cell voltages must be at least 1.55 volts minimum.

– If cell voltages are above 1.55 volts minimum, proceed to Paragraph 7.0.

– If any cell rises above 1.55 volts then decreases below 1.50 volts the cell must be replaced, proceed to Paragraph 10.0.

– If any cell voltage fails to rise to above 1.50 volts, the cell must be replaced. See Paragraph 10.0

STEP IA Connect battery to charging source and charge at the main charge rate a ***MINIMUM*** of two and one-half (2½) hours ***and*** until ***all*** cells are 1.55 volts minimum.

IF CELL(S) ARE DRY, HIGH CELL VOLTAGE MAY OCCUR (1.85 VOLTS OR GREATER). FIVE TO TEN CC's OF DISTILLED OR DEMINERALIZED WATER MAY BE ADDED TO EACH CELL.

After completion of the main charge with all cells at 1.55 volts minimum, reduce charge current to the topping charge rate and top charge for two (2) hours. Adjust electrolyte level during the final 15 minutes of the topping charge in accordance with Paragraph 6.0. Upon completion of the topping charge, while still on charge, all cell voltages must be at least 1.55 volts minimum.

Or

For charging with a reflex charger, charge at the reflex charge rate for 1 hour followed by a constant current topping charge for 2 hours. Adjust the electrolyte level during the final 15 minutes of the topping charge. The requirements below are applicable to the topping charge.

— If cell voltages are above 1.55 volts minimum, proceed to Paragraph 7.0

— If any cell voltage rises above 1.55 volts and then decreases below 1.50 volts, the cell must be replaced, proceed to Paragraph 10.0.

— If any cell voltage fails to rise to above 1.50 volts, the cell must be replaced. See Paragraph 10.0

Reflex and Constant Current Charging Rates

CELL TYPE	REFLEX CHARGING	CONSTANT CURRENT CHARGING		
	1 HOUR REFLEX MODE AMPS	MAIN CHARGE AMPS	TOPPING CHARGE AMPS	TRICKLE CHARGE RATE MILLIAMPS
3H120	6	1.8	0.8	6
5H120	10	3.2	1.3	10
10H120	20	6.5	2.6	20
12H120	24	7.5	3.0	24
12M220	24	7.5	3.0	24
14M220	28	8.5	3.4	28
15M220	26	8.5	3.4	26
15SP100	26	8.5	3.4	26
17H100	34	9.0	3.6	34
17SP100	34	9.0	3.6	34
18H120	34	9.0	3.6	34
20SPE100	40	14.0	5.6	40
20H120	40	11.0	4.4	40
24H100	48	13.0	5.2	48
24SP100	48	13.0	5.2	48
24H120	48	13.0	5.2	48
24M220	48	13.5	5.4	48
24ME220	48	13.5	5.4	48
25SP100	48	13.5	5.4	4.8
28SP100	56	15.0	6.0	56
36H120	80	21.0	8.4	80
38H100	76	23.0	9.2	76
38SP100	76	23.0	9.2	76
40SP100	80	23.0	9.2	80
40SP100L	80	23.0	9.2	80
44SP100	80	24.0	9.6	88
44SP100L	80	24.0	9.6	88
46SPE100	80	24.0	9.6	92
52H120C	80	30.0	12.0	104
65H132	80	32.5	13.0	120
81H120	80	42.5	17.0	160

TABLE 4
REFLEX and CONSTANT CURRENT CHARGE PROCEDURES

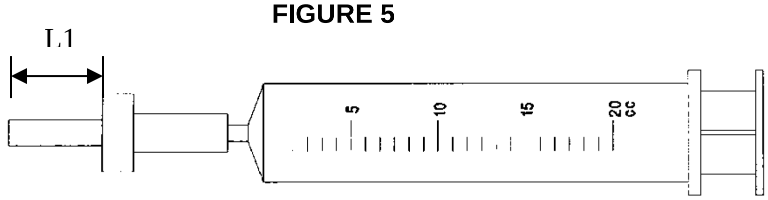
6.0 ELECTROLYTE LEVEL ADJUSTMENT

During the last 15 minutes of the topping charge, and while the current is still flowing, the cells are at their most uniform electrolyte level, and it is at this time that the electrolyte level can be most accurately adjusted.

The electrolyte level should be adjusted using the syringe and appropriate nozzle (available in kit P/N 32480-001).

Electrolyte level adjustments must be made with distilled, deionized or demineralized water only

FIGURE 5



SYRINGE AND NOZZLE ASSEMBLY

SYRINGE & NOZZLE ASSEMBLY APPLICATION

TABLE 5

ITEM #1 SYRINGE P/N	ITEM #2 NOZZLE P/N	NOZZLE LENGTH (L1)	NOZZLE COLOR	CELL TYPE
32415-001	32479-001	7/8" (22mm)	Green	12H120, 12M220, 14M220, 15M220, 15SP100, 18H120, 20H120, 24M220, 24H120, 24H100, 24SP100, 25SP100, 28SP100, 36H120, 38H100, 38SP100, 40SP100, 44SP100, 40SP100L, 44SP100L, 52H120C
	32479-002	1-1/16" (27 mm)	White	3H120, 5H120, 17SP100, 17H100, 46SPE100, 20SPE100
	32479-003	5/8" (16 mm)	Blue	10H120, 65H132
	32479-004	2" (51 mm)	Black	24ME220

Battery cells with aerobatic vents require special electrolyte adjustment procedures. Contact MarathonNorco for further information.

6.1 Electrolyte Level Adjustment Procedure

Insert the syringe with the appropriate nozzle into the cell opening until the shoulder of the nozzle rests firmly on the "O" ring seat. Withdraw the plunger and check for any electrolyte in the syringe. If the level is too low the syringe will remain empty. If the level is too high any excess electrolyte will be drawn into the syringe until the level corresponds to the depth of the nozzle insertion into the cell. The depth of the nozzle into the cell is the correct electrolyte level.

If the electrolyte level is too low (the syringe remained empty) draw 10 CC's of distilled or demineralized water into the syringe and inject it into the cell. Withdraw the plunger. If the syringe remains empty continue injecting measured quantities of water into the cell to achieve the correct level.

At the point where some excess electrolyte is drawn into the syringe the correct electrolyte level for that cell has been achieved. Discharge any excess electrolyte.

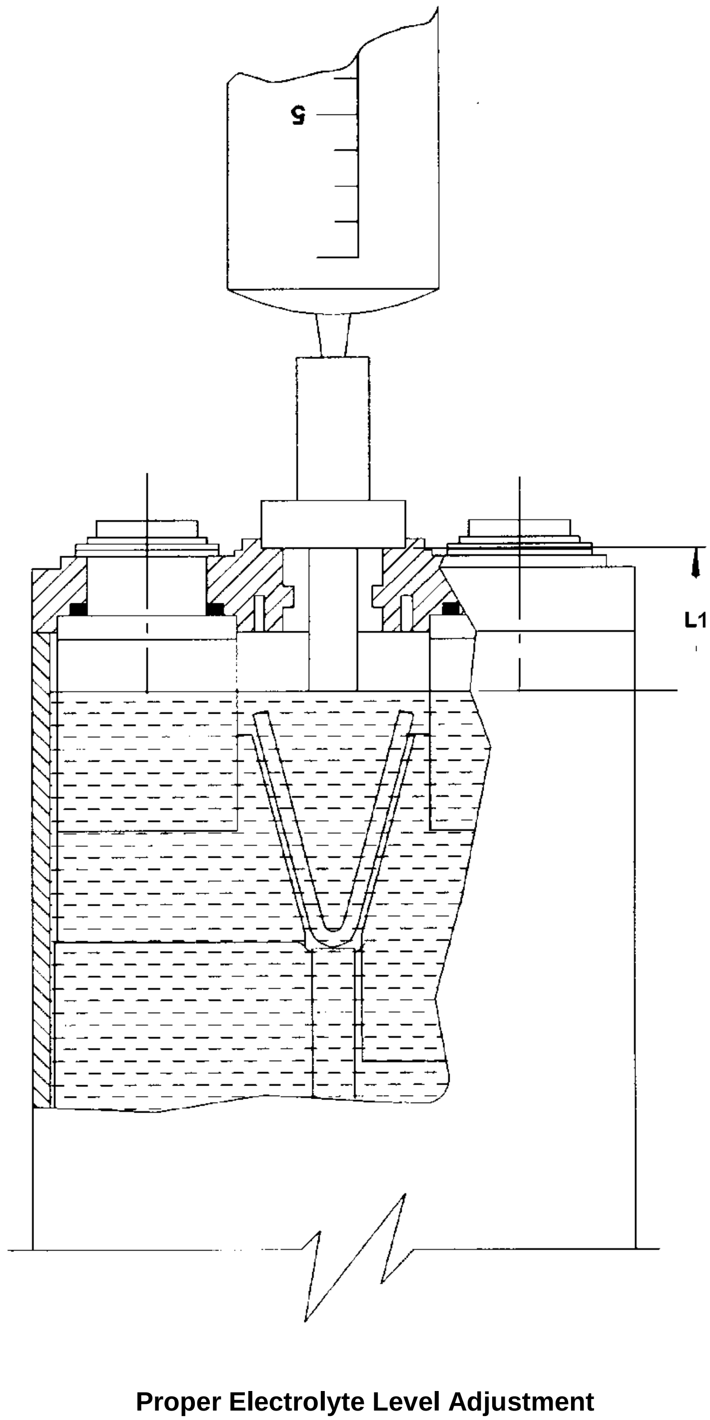
The amount of water required to fill the first cell should serve as an indication of the quantity required to fill the remaining cells. However, the electrolyte level must be independently adjusted in each cell.

Check to see that the quantity of water added per cell does not exceed the maximum allowable for that cell type in Table 5. If the water consumption is too high, the service interval may need to be reduced and/or check the charging system or voltage regulator setting.

TABLE 6

MAXIMUM ALLOWABLE WATER CONSUMPTION

CELL TYPE	VOLUME (cc)
3H120	3.5
5H120	4.5
10H120	8.0
12M220	31.0
12H120	31.0
14M220	25.0
15M220	25.0
15SP100	25.0
17H100	16.0
17SP100	16.0
18H120	10.0
20SPE100	20.0
20H120	20.0
24M220	30.0
24H120	30.0
24ME220	96.0
24SP100	30.0
25SP100	30.0
28SP100	24.0
36M220	37.0
36H120	37.0
38H100	78.0
38SP100	78.0
40SP100	34.0
40SP100L	75.0
44SP100	34.0
44SP100L	34.0
46SPE100	85.0
52H120C	142.0
65H132	53.0



Proper Electrolyte Level Adjustment

FIGURE 6

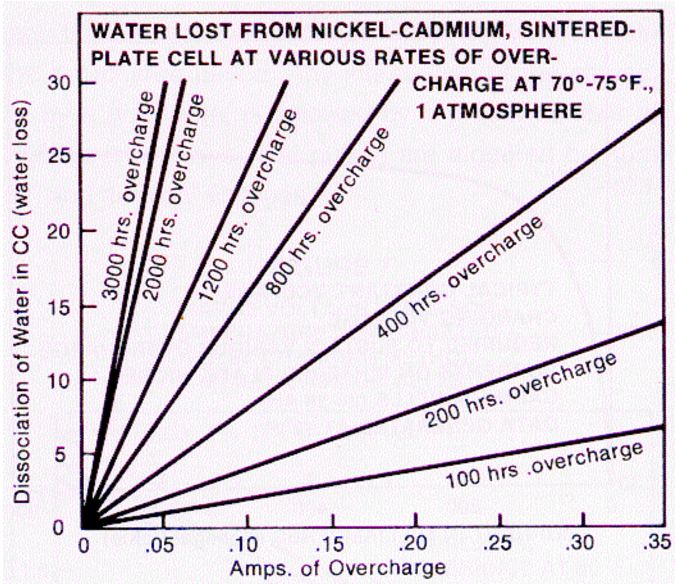


FIGURE 7

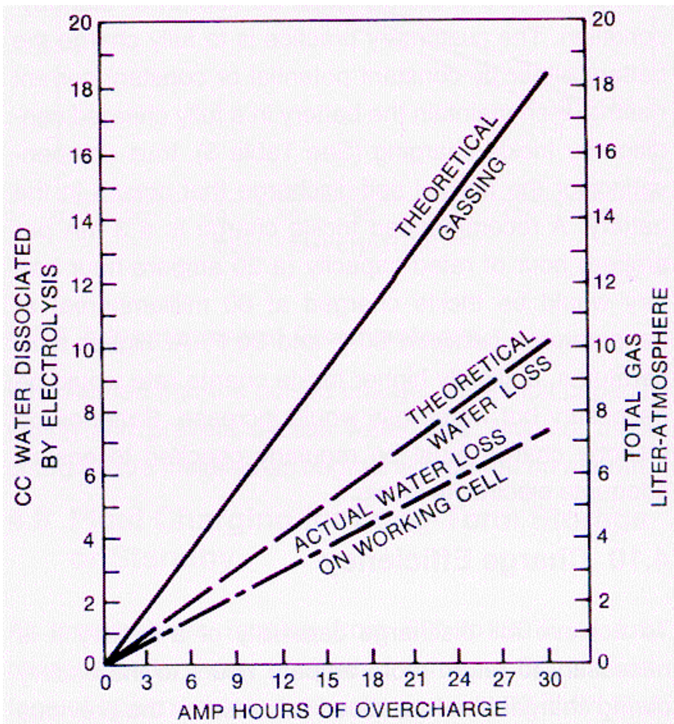


FIGURE 8

7.0 CAPACITY TEST

If following a charge, a noticeable rise in battery temperature has occurred (warm to the hand) allow the battery to cool prior to proceeding with capacity test. When battery is cool proceed with capacity test (measure discharge versus time) using one of the following discharge rates:

- C-rate for 51 minutes - 85% capacity requirement to minimum acceptable end voltage of 1.0 volts per cell for in-service batteries.
- C-rate for 60 minutes minimum for new batteries.

OR

- C/2 rate for 102 minutes - 85% capacity requirements to minimum acceptable end voltage of 1.0 volts per cell for in-service batteries.
- C/2 rate for 120 minutes minimum for new batteries.

7.1 Interpretation of Capacity Test

If no cells have dropped below 1.0 volt before or at the end of the specified time, stop discharge. The battery has successfully completed the capacity test.

If cells have dropped below 1.0 volt before or at the end of the specified capacity test time, do not stop discharge. Battery must be reconditioned (deep cycled) according to Paragraph 8.0.

7.2 Boeing 100%

The following products for use on Boeing aircraft must meet C-Rate for 60 minutes or C/2 rate for 120 minutes on both new and in-service batteries.

MPTC Model	MPTC P/N	Boeing P/N
CA-27-20	28111-003	10-60707-9
CA-727-20	25582-003	10-60707-10
KCA-727-20	29069-002	10-60707-11
CA-27-20C	28111-004	10-60707-15
CA-727-20CR	25582-006	10-60707-16
KCA-727-20CR	29069-004	10-60707-17
CA-727-20	25582-003	10-60707-10
CA-727-20CR	25582-006	10-60707-16

7.3 TCA-109L-1 (32864-001) and TCA-1069L (33296-001)

These products must deliver 78 minutes to 20.0 V at a 10 amp rate for new batteries.

Table 7

CAPACITY TEST AMPERES		
Cell Type	**"C" Rate**	**C/2 Rate**
3H120	3	1.5
5H120	5	2.5
10H120	10	5.0
12M220	12	6.0
12H120	12	6.0
14M220	14	7.0
15M220	13	6.5
15SP100	15	7.5
17H100	17	8.5
17SP100	17	8.5
18H120	17	8.5
20SPE100	20	10.0
20H120	20	10.0
24M220CR	24	12.0
24ME220	24	12.0
24H120	24	12.0
24SP100	24	12.0
25SP100	25	12.5
28SP100	28	14.0
36H120	40	20.0
38H100	38	19.0
38SP100	38	19.0
40SP100	40	20.0
40SP100L	40	20.0
44SP100	44	22.0
44SP100L	44	22.0
46SPE100	46	23.0
52H120C	52	26.0
65H132	60	30.0
81H120	80	40.0

8.0 RECONDITIONING

8.1 When reconditioning is required discharge the battery until cells reach 0.5 volts or less. Place a short-out clip across each cell once it has reached 0.5 volts or less.

When all cells have a short-out clip attached, turn off discharge unit.

For reconditioning, allow battery to stand in a shorted condition for a minimum of 4 hours, preferably overnight. See 8.2 below.

For long term storage, remove cell short out clips, short out battery at battery main connector and place into storage.

8.2 Remove short-out clips and return to Paragraphs 5.0, Step 1A.

- A severely unbalanced battery may need to be deep cycled as many as three times to restore its capacity.

- If after three (3) deep cycles some cells still have not had their capacity restored, these cells should be replaced.

- If 25% or more of the total number of cells within a battery are found to be defective, either at one time or over a period of time, it is recommended that all cells be replaced.

9.0 CLEANING

CAUTION: Exercise extreme care when working around the battery. Do not use metal brushes or metal brush supports. Remove rings and other metal jewelry from the hands. Any of these may cause an electrical short which may result in skin burns and damage to the battery.

The battery should be kept in a clean, dry state for optimum performance. The extent of the cleaning process depends upon the condition of the battery. Several procedures are described in the following paragraphs.

If heavy overcharging has occurred, gassing and spewing of electrolyte may cause a white powdery substance, potassium carbonate, to form on top of the cells. This may be removed by brushing the cells with a non-conductive stiff bristle brush or a clean cloth.

If necessary, the tops of the cells may be flushed with ordinary tap water (of low mineral content). Make certain that all of the cell vent plugs are properly seated. Tip the battery at about a 45° angle with its receptacle (or power connector) facing upward. Flush with water from the top of the battery in a downward direction so as to prevent, as much as possible, any water from entering the battery can. It is permissible to use a non-conductive bristle brush to clean away stubborn dirt particles. Any excess liquid should be drained off and the battery permitted to dry. Drying may be accelerated by the use of oil-free compressed air.

WARNING: USE OF COMPRESSED AIR FOR CLEANING CAN CREATE AN ENVIRONMENT OF PROPELLED FOREIGN PARTICLES WHICH MAY ENTER THE EYES AND CAUSE SERIOUS INJURY. AIR PRESSURE FOR CLEANING SHALL NOT EXCEED 30 PSI. EFFECTIVE CHIP GUARDING INCLUDING EYE PROTECTION IS REQUIRED.

CAUTION: THE WATER USED TO WASH THE CELLS OR BATTERY WILL BECOME CAUSTIC; AVOID CONTACT WITH IT. DO NOT CLEAN WITH SOLVENTS, ACIDS OR ANY CHEMICAL SOLUTION. THESE MAY DAMAGE THE CELL CASE AND HARDWARE.

If the battery has liquid electrolyte on the top of the cells, drain off as much as possible, wash with water, and air dry. If the electrolyte has overflowed to the extent that it has run down between the cells, the battery should be completely discharged, disassembled, and completely cleaned before reassembling.

1. Disassembly -- Disassemble the battery as described in 11.0.

2. With the vent valves in place and locked, wash the cells under running water. Do not allow the wash water to enter the cell's interior.

3. Dry the cells with clean absorbent toweling or with an air hose.

4. Inspect each cell for cracks, holes or other defective condition. If any defects are found; replace with new cells.

5. Wash and clean all hardware to remove accumulated dirt and carbonate deposits. Heavy deposits may be removed by scrubbing with a stiff bristle brush. Corrosion preventive greases may be removed from connectors, screws, nuts, and washers by washing in alcohol or by degreasing after they are removed from the cells.

6. Allow all parts to dry thoroughly before reassembling.

7. Inspect all parts and replace those that are damaged or heavily corroded. Replace connecting straps that are burned, bent or have defective nickel plating. Polish tarnished connecting straps with an eraser being careful not to remove the plating.

8. Check the battery power receptacle for burns, cracks and bent or pitted terminals. Replace defective receptacles. They can overheat, arc, depress battery voltage and cause premature battery failure.

9. Repair or replace damaged battery cases and covers, loose or damaged cover gaskets and cell hold down bars.

10. Reassemble battery (See 11.0)

11. Clean vent caps (vent plugs). Use hot water to thoroughly wash vent assemblies.

10.0 REPLACEMENT OF CELLS AND BATTERY REPAIR

10.1 Replacement of Damaged or Defective Cells

If a cell becomes contaminated, physically damaged, or is defective and must be replaced, proceed as follows:

1. Discharge the entire battery as per Paragraphs 7.0 / 8.0, remove the shorting clips.

2. Clean the battery (Paragraph 9.0)

3. Remove enough intercell connectors to permit the cell to be withdrawn from the battery can.

4. Do not withdraw a cell from the battery unless a discharged or shorted replacement cell is immediately available.

5. Withdraw the cell, using a cell puller. Always tighten the puller to the cell and pull in a straight-up direction.

6. Insert the new (discharged) cell, making certain to insert the cell with the polarity symbols in the right direction. (Cells are connected plus to minus). If the cell is difficult to insert, apply a light coat of petroleum jelly or silicone grease to the sides of the cell case before inserting.

7. Replace the intercell connectors, assembling the hardware finger tight.

CAUTION: MarathonNorco battery cells and other components are specifically designed to perform as an integral unit within the battery. Failure to use the proper replacement cells will change the batteries internal resistance and adversely affect the batteries charge and discharge capabilities.

8. Torque the terminal connection to the values indicated in Table 2 using a calibrated torque wrench.

9. Charge the battery in accordance with STEP IA.

10.2 Replacement of Damaged Power Connectors

In some battery types, the battery is provided with a special quick disconnect receptacle, such as a type manufactured by Elcon or Cannon, or any of a number of MS type receptacles. Should one of these become damaged, it will be necessary to replace it with a replacement part obtained from your local MarathonNorco authorized distributor. Care should be taken in the removal of this connector to preserve all the hardware and gasketing, if possible, so that the new part may be installed properly.

To remove the connector, first remove those connections which go to the end cells in the battery, thus reducing the possibility of a short circuit when the connector body is removed from the battery can. All MarathonNorco batteries have the same hardware arrangement for attaching the power connector to the battery as is used on the intercell connectors. When installing the replacement part, it is necessary to consult Table 2 for the torque values.

CAUTION: Use only cells, intercell connectors, power connectors and all other battery components that are specified on the battery parts list for your battery. Failure to do so will result in imbalances between the cells within the battery and could create a safety of flight issue.

11.0 BATTERY DISASSEMBLY AND REASSEMBLY

CAUTION: Exercise care when working around the battery. Avoid the use of uninsulated tools - severe arcing may result with possible harm to personnel and damage to the tools and a cell or cells in the battery.

Rings, metal watchbands and identification bracelets should be removed. In contact with intercell connectors of opposite polarity, metal objects may fuse themselves to the connectors and cause severe skin burns. Keep flames away from the battery.

11.1 Battery Disassembly

Before disassembling the battery, make sure that all cells are completely discharged. This may be accomplished as follows:

1. Discharge the battery to approximately 0.5 volts per cell, and attach shorting clips (Refer to Paragraph 7.0 and Paragraph 8.0).

2. After all cells have been discharged, remove the shorting clips. Remove all intercell connecting links. The cells may now be removed. Use a cell puller if necessary. When removing cells from a battery. Always tighten the puller to the cell and use an even, straight-up pull.

11.2 Battery Reassembly

1. Lightly polish the cells' terminal surfaces with an eraser and wipe clean.

2. Reassemble the cells into the battery can. Position the cells correctly with respect to polarity as shown on the illustrated parts list (IPL) applicable to the particular battery being serviced. DO NOT HAMMER TIGHT CELLS INTO THE BATTERY CAN: USE A STEADY FORCE ON THE TERMINALS TO PRESS THEM INTO PLACE. FOR EASIEST ASSEMBLY, THE CELL AT THE MIDDLE OF A ROW SHOULD BE INSERTED LAST.

3. Place intercell connectors, and other components, in their correct position as shown on the Illustrated Parts List (IPL).

4. Install all hardware finger-tight.

CAUTION: Use only cells, intercell connectors, power connectors and all other battery components that are specified on the battery parts list for your battery. Failure to do so will result in imbalances between the cells within the battery and could create a safety of flight issue.

Starting at the positive terminal of the battery, tighten each terminal screw to the torque specified in Table 2.

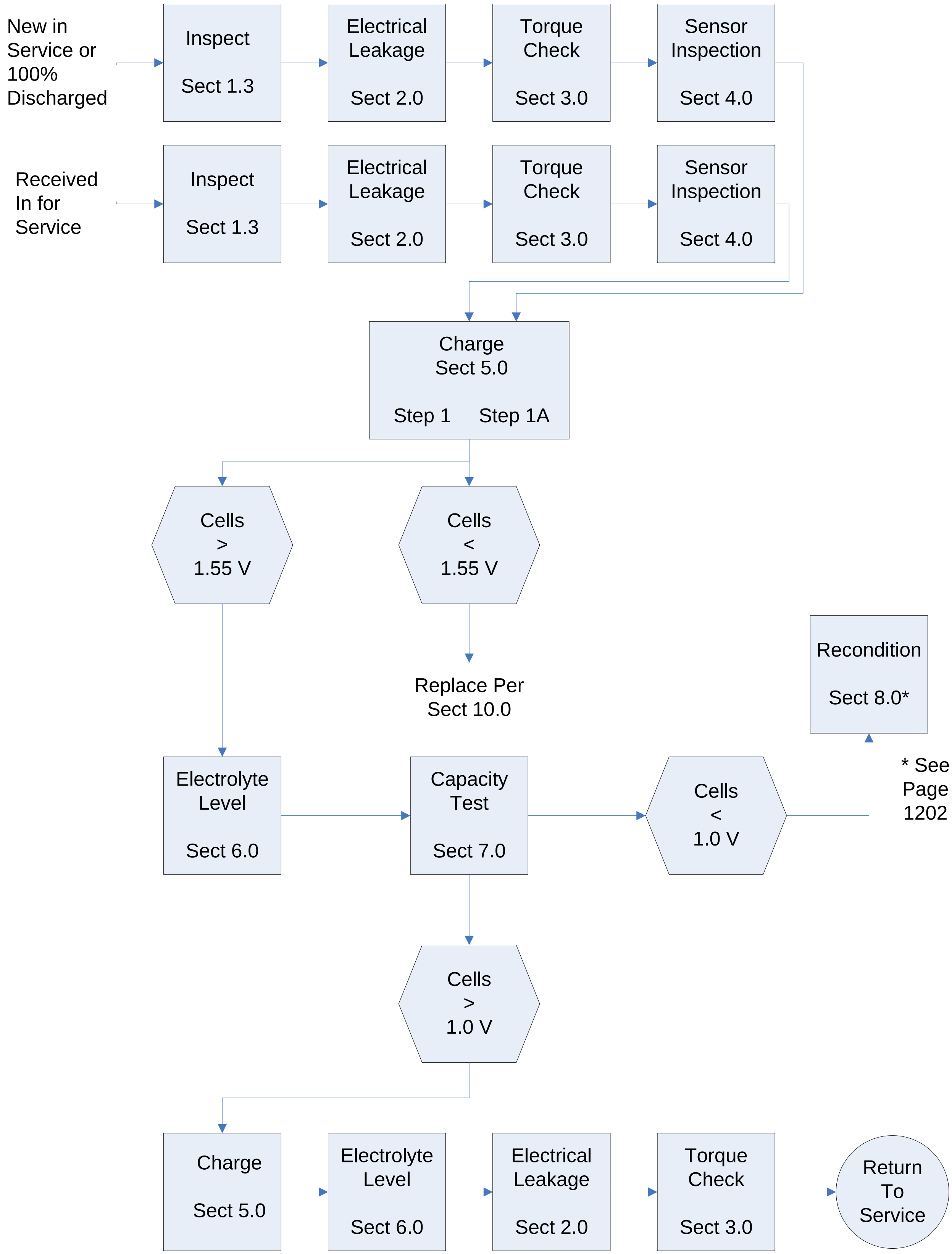
CARE SHOULD BE TAKEN TO INSURE THAT THE TERMINAL SCREW IS NOT BINDING, DUE TO THREAD DAMAGE, OR BOTTOMING, BUT IS ACTUALLY TIGHTENING THE CONNECTOR. IMPROPER TORQUE MAY RESULT IN DAMAGE TO THE BATTERY.

Some batteries contain flat-sided washers as part of the terminal hardware. The flat side serves as a visual indicator during torquing. During initial thread engagement the washer rotates, and upon tightening, rotation stops. This indicates to the operator that the screw is tightened in the terminal and was not binding or bottoming when the proper torque was reached.

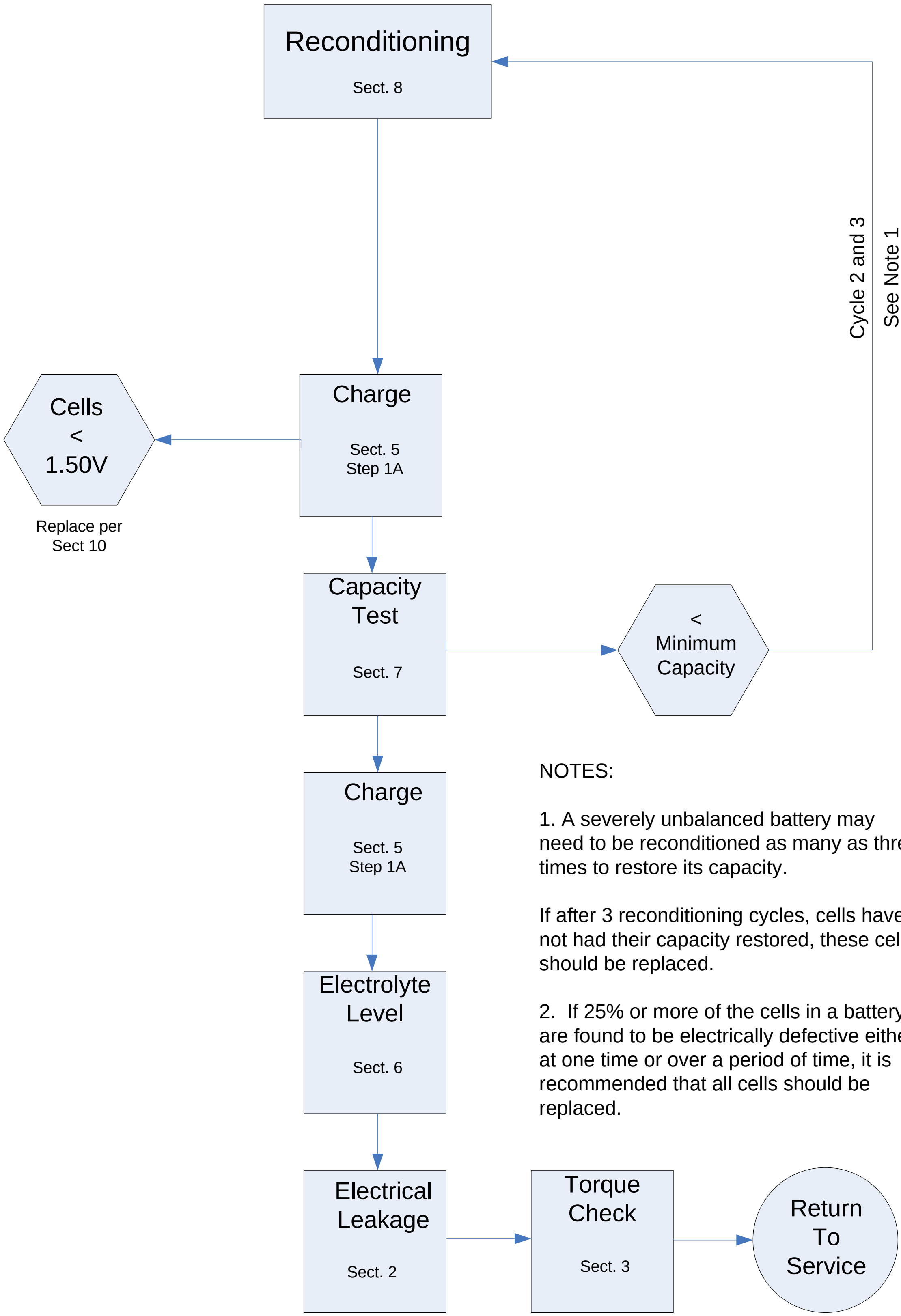
It is good practice to follow the battery assembly IPL during final retightening as this is a good double check of the correct electrical order. Do not skip around over cells; do not leave the job partially completed and come back to it. Finish the complete battery reassembly once it is started. Forgetting where the tightening job was stopped is a good way to miss a screw or nut. One loose connection can permanently damage a battery and **may cause an explosion**.

12.0 Battery Maintenance Flow Chart

BATTERY MAINTENANCE FLOW CHART



BATTERY RECONDITIONING FLOW CHART



NOTES:

1. A severely unbalanced battery may need to be reconditioned as many as three times to restore its capacity.

If after 3 reconditioning cycles, cells have not had their capacity restored, these cells should be replaced.

2. If 25% or more of the cells in a battery are found to be electrically defective either at one time or over a period of time, it is recommended that all cells should be replaced.

13.0 TROUBLE-SHOOTING

TROUBLE-SHOOTING HINTS

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
APPARENT LOSS OF CAPACITY	Very common when recharging on a constant potential bus, as in aircraft. Usually indicates imbalance between cells because of difference in temperature, charge efficiency, self-discharge rate, etc., in the cells.	RECONDITIONING WILL ALLEVIATE THIS CONDITION.
	Electrolyte level too low. Battery not fully charged.	CHARGE. ADJUST ELECTROLYTE LEVEL. CHECK AIRCRAFT VOLTAGE REGULATOR. IF O.K., REDUCE MAINTENANCE INTERVAL.
	Use of unapproved cells and/or components.	REPLACE WITH APPROVED PARTS.
COMPLETE FAILURE TO OPERATE	Defective connection in equipment circuitry in which battery is installed - such as broken lead, inoperative relay or improper receptacle installation.	CHECK AND CORRECT EXTERNAL CIRCUITRY.
	End terminal connector loose or disengaged. Poor intercell connections.	CLEAN AND RETIGHTEN HARDWARE USING PROPER TORQUE VALUES.
	Open circuit or dry cell.	REPLACE DEFECTIVE CELL
	Use of unapproved cells and/or components	REPLACE WITH APPROVED PARTS.
EXCESSIVE SPEWAGE OF ELECTROLYTE	High charge voltage High temperature during charge Electrolyte level too high	CLEAN BATTERY, CHARGE AND ADJUST ELECTROLYTE LEVEL.
	Loose or damaged vent cap	CLEAN BATTERY, TIGHTEN OR REPLACE CAP, CHARGE AND ADJUST ELECTROLYTE LEVEL
	Damaged cell and seal	SHORT OUT ALL CELLS TO 0 VOLTS, CLEAN BATTERY, REPLACE DEFECTIVE CELL, CHARGE AND ADJUST ELECTROLYTE LEVEL.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
FAILURE OF ONE OR MORE CELLS TO RISE TO THE REQUIRED 1.55 VOLTS AT THE END OF CHARGE.	Negative Electrode not fully charged. Cellophane separator damage.	DISCHARGE BATTERY AND RECHARGE. IF THE CELL STILL FAILS TO RISE TO 1.55 VOLTS OR IF THE CELL'S VOLTAGE RISES TO 1.55 VOLTS OR ABOVE AND THEN DROPS, REMOVE CELL AND REPLACE.
DISTORTION OF CELL CASE TO COVER.	Overcharged, overdischarged, or overheated cell with internal short. Plugged vent cap Overheated battery	DISCHARGE BATTERY AND DISASSEMBLE. REPLACE DEFECTIVE CELL. RECONDITION BATTERY. REPLACE VENT CAP CHECK VOLTAGE REGULATOR: TREAT BATTERY AS ABOVE, REPLACING BATTERY CASE AND COVER AND ALL OTHER DEFECTIVE PARTS.
FOREIGN MATERIAL WITHIN THE CELL CASE	Introduced into cell through addition of impure water or water contaminated with acid.	DISCHARGE BATTERY AND DISASSEMBLE, REMOVE CELL AND REPLACE, RECONDITION BATTERY.
FREQUENT ADDITION OF WATER	Cell out of balance Damaged "O" ring, vent cap Leaking cell Charge voltage too high	RECONDITION BATTERY REPLACE DAMAGED PARTS. DISCHARGE BATTERY AND DISASSEMBLE. REPLACE DEFECTIVE CELL, RECONDITION BATTERY. ADJUST VOLTAGE REGULATOR
CORROSION OF TOP HARDWARE	Acid fumes or spray or other corrosive atmosphere	REPLACE PARTS. BATTERY SHOULD BE KEPT CLEAN AND KEPT AWAY FROM SUCH ENVIRONMENTS
DISCOLORED OR BURNED END CONNECTORS OR INTERCELL CONNECTORS	Dirty connections Loose connection Improper mating of parts	CLEAN PARTS: REPLACE IF NECESSARY. RETIGHTEN HARDWARE USING PROPER TORQUE VALUES. CHECK TO SEE THAT PARTS ARE PROPERLY MATED.
DISTORTION OF BATTERY CASE AND/OR COVER	Explosion caused by: Dry cells Charger failure High charge voltage Plugged vent caps Loose intercell connectors	DISCHARGE BATTERY AND DISASSEMBLE REPLACE DAMAGED PARTS AND RECONDITION.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
CELL TO BATTERY CAN LEAKAGE TO GROUND DETECTED BY TESTING	Excessive spewage	CLEAN BATTERY, CHARGE AND ADJUST ELECTROLYTE LEVEL. RECHECK FOR ELECTRICAL LEAKAGE.
	Damaged cell case to cover seal.	DISCHARGE BATTERY AND DISASSEMBLE, REPLACE DEFECTIVE CELL, RECONDITION BATTERY.
FOAMING OF ELECTROLYTE DURING CHARGE	Contaminant in electrolyte	DISCHARGE BATTERY AND REPLACE DEFECTIVE CELL. RECONDITION BATTERY. REPLACE CELL THAT CONTINUES TO FOAM
FALSE OR NO BATTERY HIGH TEMPERATURE INDICATION	Dirty connections	CLEAN PARTS
	Loose connections Improper mating of parts	INSPECT AND RETIGHTEN RECEPTACLE
	Shorted thermistor or receptacle due to KOH intrusion	REPLACE SENSOR ASSEMBLY

14.0 STORAGE

14.1 Inactive Storage

Inactive storage is where the battery is stored for long periods of time. The battery should be stored in a completely discharged, shorted out condition. (See Section 8.1). Nickel-cadmium batteries may be stored in a non-corrosive atmosphere for an unlimited period at temperatures ranging from -65° to + 120°F; the upper limit may be extended to + 160°F for up to two weeks.

14.2 Active Storage

Active storage is where a fully charged battery is stored temporarily prior to going into service. Nickel-cadmium batteries will incur only a temporary loss of capacity during active storage. The charge retention depends largely on the ambient temperature in which the battery is stored and the length of time in storage. Charge retention is also affected by impurities in the electrolyte and electrical leakage from cells to battery case. Storage at higher temperatures will result in a greater loss of charge; at low temperatures, this loss will be much less.

Before placing a battery into active storage, the battery should be fully serviced and cleaned. Where operation is required immediately after removal from active storage, proper cleaning is even more important to avoid the possibility of contaminants creating conductive paths within the battery case and increasing the self-discharge rate.

A properly serviced battery can be stored at temperatures between 60°F and 80°F for up to 90 days. Beyond this time or temperature the battery should be serviced before being placed into service.

14.3 Extending Active Storage Shelf Life

If the battery is to be placed into an active storage condition, for longer periods, the battery should be serviced then maintained in a fully charged condition by trickle charging, thus compensating for the normal self discharge that occurs in the battery. Trickle charge rates are given in table 4 of this manual. Batteries stored under this condition must be kept at a temperature between 60°F and 80°F. Maximum trickle charge time prior to placement into service is one year. Beyond this time or temperature the battery should be serviced before being returned to active storage or being placed into service.

NOTE: Trickle charge rates are critical. Charging at a rate greater or less than the recommended rate can create significant problems.

15.0 SHIPPING

Shipments must conform to current IATA regulations (UN2795 or UN2800 as applicable). See the SDS for further information.

Current SDS can be downloaded off the MarathonNorco Aerospace Website: www.mnaerospace.com.

16.0 WARRANTY INFORMATION

16.1 Product Warranty Registration

MarathonNorco Aerospace, Inc. includes a warranty registration card with the shipment of each new vented nickel-cadmium battery. The warranty registration card must be validated by a MarathonNorco Aerospace, Inc. authorized distributor/dealer, then filled out and mailed within 30 days of the date of purchase to MarathonNorco Aerospace, Inc.

17.0 SPECIAL TOOLS/RECOMMENDED EQUIPMENT

17.1 Nickel-cadmium Battery Maintenance Kit

MarathonNorco Aerospace, Inc. has made available through distributors, a battery maintenance kit (P/N 32480-001). Items contained within the kit are listed as follows:

QTY REQUIRED	DESCRIPTION	PART NO.
1	Case, Marked w/Pads	32535-001
5	Short Out Resistor	14000-001
1	Hex Bit Socket Size 3/16, 3/8 Drive	33180-001
22	Discharge Clip	31379-001
1	Cell Puller, Universal	32515-001
1	Vent Wrench	25624-001
1	Socket Bit (T-30)	30938-001
1	Adapter, Syringe Tip Black	32479-004
1	Adapter, Syringe Tip Blue	32479-003
1	Adapter, Syringe Tip White	32479-002
1	Adapter, Syringe Tip Green	32479-001
1	Syringe, 20cc	32415-001

17.2 Recommended Equipment

For charging and discharging batteries, MarathonNorco Aerospace, Inc recommends a Christie RF80-M (123020-001) or RF80-K (121630-001 or -006) or equivalent:
Charge: 50 VDC Max; 65A recommended
Discharge: 50 A Min recommended

CAUTION: It is not recommended to operate charging equipment capable of greater than 50 VDC output. The EU and other international safety organizations require a voltage limit of less than 50 VDC on battery chargers for operator safety

DISCUSSION:

In servicing Nickel Cadmium batteries the operator is subjected to the charge and discharge voltage potential because all intercell connectors and terminals are exposed conductors. In the servicing of a normal 20 cell Nickel Cadmium battery this is not an issue because the voltage potential across the battery during the servicing routine (20 cells X 1.9 V/cell = 38 VDC) is not enough to overcome the insulation resistance of the skin.

However, there are battery chargers commonly used in the aviation industry that both charge and discharge 19 or 20 cell batteries in series. **This series charging and discharging can result in the operator being exposed to a DC voltage potential as high as 76 VDC (40 cells X 1.9 V/cell) creating a *potential electrocution hazard*.**

In general, most industrial safety standards identify greater than 50 VDC as the point at which DC voltages can pose a potential safety (electrocution) hazard. **For example, the EU Low Voltage Safety directive EN°60335-1:2002 (with EN 60335-2-29:2004 calling out particular safety requirements for battery chargers) requires an output voltage on battery chargers less than 42.4 VDC.**

Servicing 19 or 20 cell Nickel Cadmium Batteries in series can subject the operator to potentially hazardous DC voltages and should not be used. However, these chargers may be used to service one 19 or 20 cell battery at a time (or any cell number configuration where the maximum voltage during the process will not exceed 50 VDC).

18.0 Record Keeping

Associated with good maintenance practices is the keeping of accurate records. These records serve as a verification of the maintenance procedure and provide information for establishing optimum servicing schedules in keeping with individual usage of the battery.

Documentation of battery servicing is not only required for warranty consideration, it is vital to the proper diagnosis of problems. Should a battery malfunction, its complete history will then be available to assist in the determination of the problem. It must be remembered that a battery is a collection of cells and that if only battery terminal voltages are observed, the problems with an individual cell may go undetected. A strong cell will compensate for a weak cell, therefore, individual cell voltages must be observed and recorded. The Battery Service Data Sheet on Page 1802 may be utilized for most nickel-cadmium service requirements.

NOTE: In some organizations cell number 1 is the most positive. In other organizations cell number 1 is the most negative. It is important that all people within an organization utilize the same system when referring to cell positions

BATTERY SERVICE DATA SHEET

Page _______ of _______

Work Order		Battery S/N		Aircraft Type		Hours in Service	
Date		Battery Type		Aircraft No		Service Performed by	

SPECIFICATIONS

Main Chg. Amps		Cap. Test Amps		Sensor	
Top Chg. Amps		Torque in Lbs.			

INSPECTIONS

Initial Visual		Torque		Vents		Deep Cycle No	
Elect. Leakage		Connector(s)		Sensor		Final Inspection	

TESTS

MAIN CHARGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
30 Minutes																						
Time to 1.55V																						
Initial H_2O CCs																						

TOP CHARGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
15 Minutes																						
30 Minutes																						
60 Minutes																						
90 Minutes																						
120 Minutes																						
Initial H_2O CCs																						

CAPACITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
15/30 Minutes																						
30/60 Minutes																						
45/90 Minutes																						
51/120 Minutes																						

Approved for service ______________________ Date______________________