POWER PRODUCTS INC.
www.power-products.com

Designer and manufacturer of aircraft lead-acid and nickel-cadmium battery support equipment since 1980. Headquarters and main plant located in San Rafael, California. Technical support in California and New York City.

Cage Code: 0BC70 DUNS: 161210885

ACTIVATOR 282

2 ampere automatic charger for 24 volt aircraft batteries combining the charger and battery quick disconnect as one unit - no charge cables. 115/230 V.
NSN: 6130-01-226-6998

CA-1550

Combined 25 ampere charger and 60 ampere discharge unit in compact transit case. 115/230 V.

ALPHA C-25

0-25 ampere dual constant-current and constant-potential charger. Adjustable for all types of aircraft and other batteries. 115/230 V.
NSN: 6130-01-462-6335
6130-21-258-4429 (Canada)

BETA D-50

0-50 ampere constant-current discharge unit for all types of aircraft and other batteries. 115/230 V.
NSN: 6130-01-462-6337
6130-21-258-4430 (Canada)

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POWER PRODUCTS INC.
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CA-1550 COMMERCIAL
BATTERY CHARGER / ANALYZER

OPERATING MANUAL

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1 SYSTEM OVERVIEW

1.1 SYSTEM OVERVIEW

The CA-1550 Charger/Analyzer is a self-contained unit for charging and discharge capacity testing of rechargeable batteries. It has been designed to accurately test, charge and guarantee the emergency capacity of sealed or vented lead-acid or nickel-cadmium batteries. Guaranteed emergency capacity is especially important for aircraft batteries.

The unit comes in a convenient protective carrying case. It is very easy to move around to accommodate flexibility in the work environment, whether used portable or in the hangar or battery shop. The flexibility of charge and discharge parameters of the CA-1550 makes it usable for a wide variety of batteries and voltages. The unit accurately charges and tests lead-acid batteries of 12 or 24 volts, as well as nickel-cadmium batteries of a single cell to 24 volts.

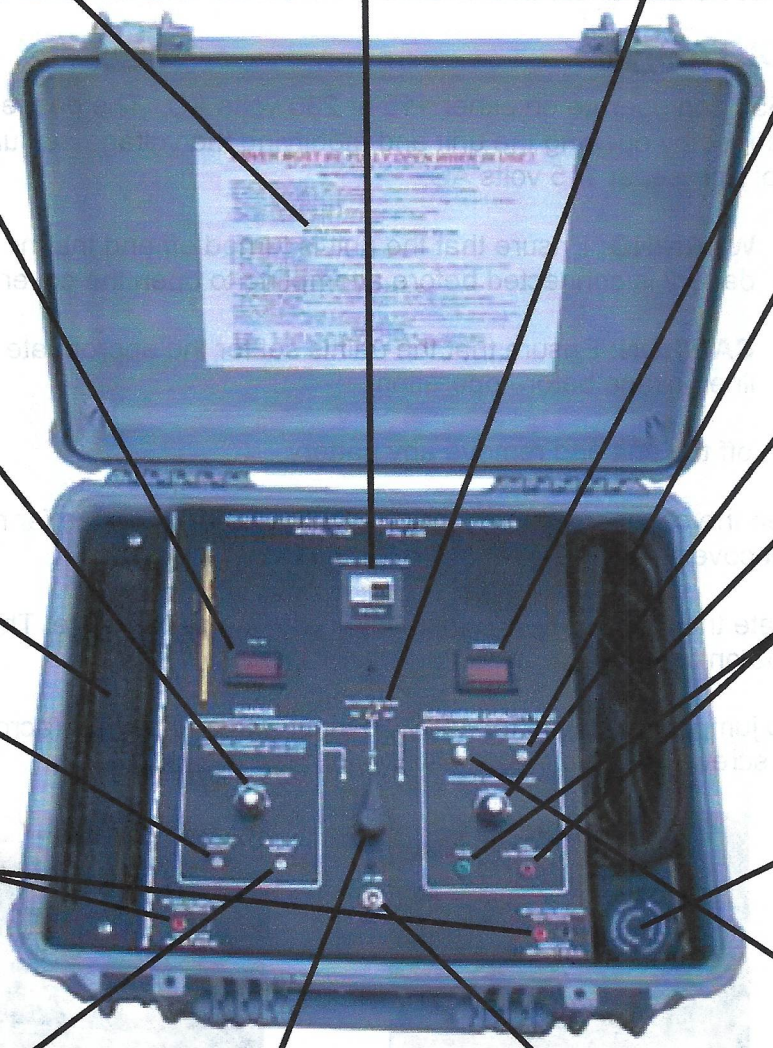
The charge unit of the CA-1550 allows charging at both constant potential and constant current to give maximum flexibility in selection of charge method. The charger has an adjustable charge current from 0 to 25 amperes, and an automatic timer for charge time selection.

The discharge unit of the CA-1550 enables battery capacity testing with a constant current of 0 to 50 amperes (usually set to 80-100% of the battery's capacity rating) for a preset time. The unit automatically analyzes the discharge characteristics and passes or fails the battery depending on the battery's ability to maintain the specified minimum voltage for the duration of the test.

1.2 DISPLAYS AND CONTROLS

The CA-1550 has been designed to have very simple and easy to understand controls and displays.

Two digital panel meters allow viewing of charge and discharge current and voltage. A digital electronic timer displays elapsed time and can be set to any fixed duration period. Light indicators display if the unit is in charge or discharge mode and also indicate battery pass or reject status after a discharge test (see Figure 1–1).



INSTRUCTION PLACARD

DIGITAL TIMER
Displays elapsed charge or discharge time.Can be set with thumb-dial

12/24 VOLT SWITCH
Selects 12 or 24 volt battery for constant potential charge

DIGITAL AMMETER
Displays charge or discharge current

DIGITAL VOLTMETER
Displays 1) battery voltage during charge or discharge; or 2) cutoff voltage
.

CUTOFF VOLTAGE ADJUST TRIMPOT
Adjusts cutoff voltage

CHARGE AMPERE ADJUST KNOB
Sets charge current

DISCHARGE AMPERE ADJUST KNOB
Sets discharge current

DISCHARGE RESISTOR

AC POWER CABLE

12 VOLT CONSTANT-POTENTIAL ADJUST TRIMPOT
Adjusts voltage for constant-potential mode

PASS/FAIL LAMP INDICATORS
Illuminate to indicate outcome of discharge test

CALIBRATION TEST POINTS
Provides output for voltmeter and ammeter calibration

BATTERY CABLE AND CONNECTOR

VOLTAGE CUTOFF VIEW BUTTON
Pressed to display and adjust cutoff voltage

24 VOLT CONSTANT-POTENTIAL ADJUST TRIMPOT
Adjusts voltage for constant-potential mode

MODE SELECT KNOB
Selects discharge or charge (constant-current or constant-

AC ON-OFF/RESET SWITCH
Turns unit on or off and resets all indicators and functions

Figure 1–1. Controls and displays of CA-1550

2 INSTALLATION

2.1 LINE VOLTAGE

The CA-1550 can operate on either 115 or 230 volts AC. The desired line voltage can be changed by opening the unit and modifying the voltage-set jumper(s). The unit is factory-preset at 115 volts AC.

WARNING: Ensure that the unit is turned off and that no battery is connected before attempting to open the cover.

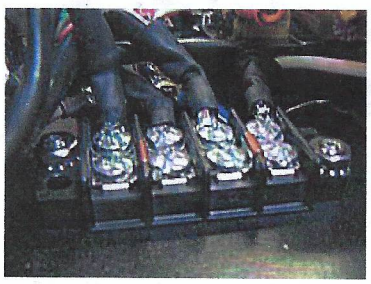
CAUTION: Ensure that the unit is set for the appropriate line voltage before operation.

A. Turn off the unit and remove any battery

B. Open the cover by first unscrewing the two screws on the far right of the front cover.

C. Locate the four position terminal strip with jumper(s). Note: There is a red stripe on top of each jumper.

D. Two jumpers are used for 115VAC input and one jumper (across the middle two screws) is used for 230VAC input. See Figures below.



115 volt AC setting

230 volt AC setting

E. For 230 VAC operation, the 115 VAC plug must be replaced with one for 230 VAC in required configuration.

NOTE: If the plug has to be changed make sure to connect the green AC line wire to ground.

Connect the unit to a wall outlet with a 15-20 ampere capacity. Sharing of the line with other equipment may result in erratic operation if other equipment draws high pulse or surge currents.

NOTE: The CA-1550 will maintain its operational integrity with line fluctuation less than ± 10%.

2.2 TERMINALS

Two important points about the DC battery cable and connector are:

A. If the aircraft battery quick disconnect connector is removed, the ring terminals can be used to connect to a post terminal battery.

WARNING: Correct polarity must be observed.

B. If the cable is extended or repaired during maintenance, the sensing leads which run with the heavy DC cable must be connected to the new terminal (see section 5.6).

2.3 SPACE REQUIREMENTS

The CA-1550 system comes in a sturdy transit case. It occupies 17" x 20" (432 mm x 508 mm) of table top space. Place the unit on a sturdy workbench in a well-ventilated area with the battery adjacent to it.

The top of the unit has air flow from hot resistors. Always leave the cover open and the resistor vent uncovered when in operation, to maintain proper air flow.

NOTE: In non air-conditioned rooms it is recommended that circulating or extracting fans be used to aid in the removal of heated air.

NOTE: Operation in dusty or otherwise dirty air environments will severely reduce the cooling capacity of the fans and can lead to premature failure.

3 OPERATING GUIDE - CHARGING

3.1 CHARGE CHARACTERISTICS

The constant current charge characteristics of a lead-acid cell with respect to cell voltage, ampere-hours input, specific gravity and rate of gassing at constant current can be seen in Figure 3–1.

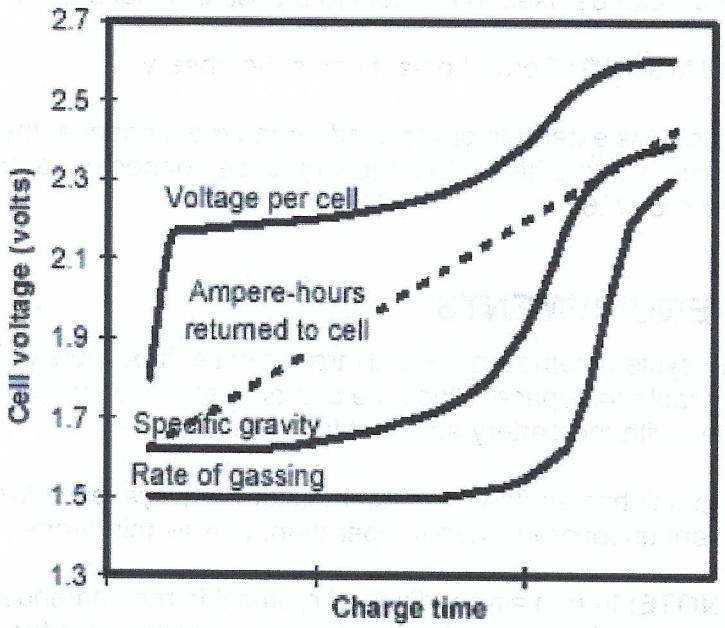


Figure 3–1. Charge characteristics of a lead-acid cell

As shown by the curve in Figure 3–1 the cell voltage of a discharged battery rises rapidly when the battery is first placed on charge. The extent of the initial rise depends on the charging rate. As the charge continues, the voltage rises at a slower rate and eventually levels off when a full state-of-charge is reached. It can be seen that the specific gravity reading lags behind the rate of ampere-hour return during most of the charging cycle. Consequently, the specific gravity is not indicative of the available ampere-hour capacity until the cell approaches a full-charge state.

When a battery reaches a full state-of-charge the voltage of the battery will stabilize and remain constant or decrease. The charging should discontinue at this stage. A minimum of 100% of previous discharge should be placed in the battery.

In general a vented battery may be charged at any rate that will not produce excessive gassing or electrolyte temperatures above 115°F (46°C). Sealed lead-

acid batteries should never be charged in a constant-current mode with a current greater than $C_t/10$ (C_t equals the rated capacity of the battery). During constant current charging at a rate in excess of C /10, oxygen is produced at an excessive rate. The resulting increasing pressure will cause the cell to vent. Venting of gasses results in a depletion of electrolyte. As the electrolyte cannot be replaced in a sealed battery, the cell will dry out resulting in a decrease in capacity and eventually battery failure. Therefore constant-potential charging is the recommended charge method for sealed batteries (SLAB).

3.2 CHARGING METHODS

There are two main methods of charging a battery: 1) constant current; and 2) constant potential. In what follows both methods will be described in some detail.

3.2.1 CONSTANT-CURRENT CHARGE METHOD (CI)

In this method the current remains at a preset level while the voltage can reach a high level, e.g. 34-37 volts.

An advantage of the constant-current charge method is that the ampere-hour input into the battery can be determined precisely by multiplying the charging current with the charge time in hours. However, it is necessary to ensure that the battery is not charged at a high rate for an excessive period of time. Such overcharging can result in overheating, excessive gassing, and possible damage to the battery.

3.2.2 CONSTANT-POTENTIAL CHARGE METHOD (CP)

A charge source applies a fixed (constant) voltage (potential) to the battery. The current supplied by the charge source fluctuates (rises and falls) with the battery voltage.

There are several advantages of the constant-potential charge method. First, there is less danger of gassing at an excessive rate. Secondly, batteries of the same nominal voltage but with different capacities can be connected in parallel directly to the charging source. Thirdly, batteries are charged more rapidly and with less attention.

3.2.3 LEAD-ACID BATTERIES

With the constant-current charge method the voltage can climb to 34-37 volts. Therefore, this method should normally not be used to charge lead-acid batteries, especially not the sealed type (SLAB). It is preferred to charge a sealed lead-acid battery in constant-potential mode at a voltage of 28.5 ± 0.2 volts for four hours or until the charge current drops below one ampere.

The constant-current charge method can however be used for reconditioning SLAB's. The current must be set low and the timer set to 12-18 hours. The battery should be periodically monitored for overheat during reconditioning. When the battery begins to accept charge current, it can be switched to constant-potential charging set to 14.25 (12 volt battery) or 28.5 volts (24 volt battery).

3.2.4 NICKEL-CADMIUM BATTERIES

Nickel-cadmium batteries may be initially charged with constant potential set to 14.25 (12 volt battery) or 28.5 (24 volt battery). After the initial charge the batteries could be topped with a low constant-current (usually C /10) charge to 1.55 volts per cell.

The nickel-cadmium can also be completely charged in the constant-current mode. The current would be adjusted to a lower rate for topping. A low constant current applied during a long time can also be used to eliminate fading, previously called the "memory effect", from nickel-cadmium batteries.

A list of recommended charge settings for the most common battery types can be found in Appendix C, but always refer to your battery manufacturer's maintenance manual for the most accurate information.

3.3 PREPARATION FOR CHARGING

Before starting charging the battery, read the component maintenance manual (CMM) or the operating and maintenance manual (OMM) for the specific battery. Ensure that the charge time and current or voltage from the battery manufacturer are followed.

It is recommended that a visual inspection of the battery is carried out in conjunction with testing and charging batteries. The charging, unless otherwise specified in the manufacturer's CMM/OMM, shall be conducted at room ambient temperature of 70°F to 85°F (21°C to 29°C). Samples of Battery Test Records including visual-inspection check lists can be found in Appendix B.

3.1.1 VERIFY END VOLTAGE

The end voltage (in all charge modes) can be verified by the following steps: 1) turn unit power off; 2) disconnect any battery; 3) turn charge current to max; 4) turn unit power on; 5) push start button; and 6) verify the end voltages on the CA-1550 digital voltmeter (see also Modify Constant Potential in section 3.5).

WARNING: Always turn the AC power switch off before connecting or disconnecting a battery

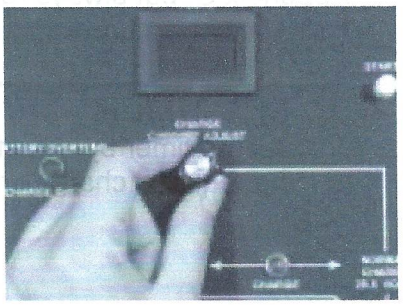
NOTE: Once set, all settings are maintained and need not be reset for duplicate charging

A. SWITCH OFF MAINS POWER

Turn off the AC on-off/reset power switch.

B. TURN DOWN CHARGE CURRENT

Repeatedly turn the Ampere Adjust knob fully counter-clockwise to set charge current to zero.



3.4 CHARGE TIME

3.4.1 TIMER UNIT SETTING

The CA-1550 has a built in timer, allowing charge time settings from 1-999 minutes.

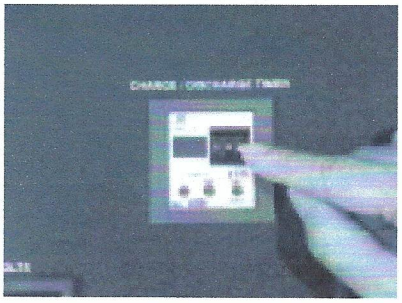
3.4.2 CHARGE TIME SETTING

The charge time will be set based on the state of charge of the battery and at which rate the battery is being charged.

A list of recommended charge times for the most common batteries can be in Appendix C, but always refer to your battery manufacturer's maintenance manual for the most accurate information.

C. SET TIMER

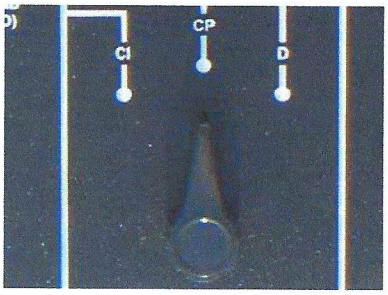
Set the timer by adjusting the thumb-dial to the required charge time.



D. SELECT CHARGE MODE

Turn the Mode Select knob to the desired charge mode: 1) Constant potential, CP; or 2) Constant current, CI.

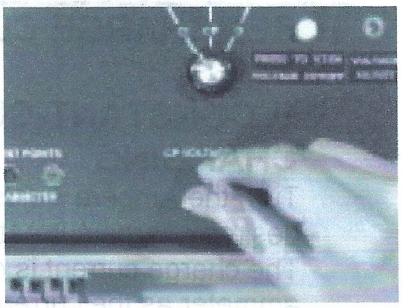
NOTE: The factory-preset 28.5 volts in constant-potential mode can, if desired, be modified in step E.



3.5 SETTING CHARGE VOLTAGE AND CURRENT

The CA-1550 provides maximum flexibility in setting charge parameters. Both the current and the voltage can be modified to accommodate different battery voltages and charge methods.

E. MODIFY CONSTANT POTENTIAL



If charging in constant-potential mode (CP), the constant charging voltage can be modified. This has to be done before connecting the battery.

1. Turn on the AC on-off/reset power switch.
2. Turn the Constant Potential Adjust Trimpot until the desired voltage is obtained. The voltmeter will display the voltage as it is being adjusted.
3. Turn off the AC on-off/reset power switch when voltage has been adjusted.

   CAUTION: Ensure the unit is turned off before connecting the battery.

F. CONNECT BATTERY

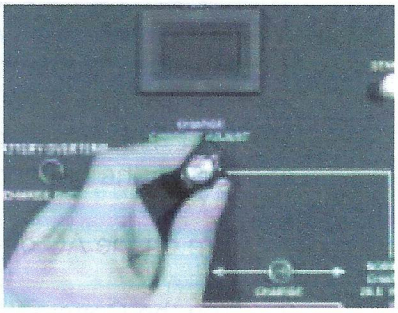
Connect the battery DC cable to the battery. Ensure the connectors are plugged in completely.

NOTE: The factory-preset 28.5 volts in constant-potential mode can, if desired, be modified in step E.

G. SWITCH ON MAINS POWER

Turn on the AC on-off/reset power switch. The voltmeter reads the battery terminal voltage, the ammeter reads zero. The timer reads 0's and its red LED is off. The Charge Mode Lamp indicator is illuminated.

H. SET CHARGE CURRENT



1. CONSTANT-CURRENT CHARGING

Turn the Ampere Adjust knob until the desired charge current has been reached. The charge current is displayed on the ammeter as the current is being adjusted.

2. CONSTANT-POTENTIAL CHARGING

Turn the Ampere Adjust knob to max (fully clockwise) or to the desired current limit. The charge current is displayed on the ammeter as the current is being adjusted.

NOTE: The CA-1550 has a current limit of 25 amperes.

I. WAIT FOR CHARGE TO AUTOMATICALLY COMPLETE

During the charging of the battery the battery voltage, charge current, and elapsed charge time are displayed.

1. CONSTANT-CURRENT CHARGING

The current remains constant while the voltage increases during the time of charging.

2. CONSTANT-POTENTIAL CHARGING

The charger's end voltage remains constant while the current starts at a high value and gradually approaches zero as the battery approaches a full charge.

The actual charge voltage in both modes is determined by the battery, until the constant voltage is reached (28.5 volts or 35 volts in constant-current mode).

The test completes when the set charge time has been reached. The Off lamp illuminates.

For the constant-current method, if a second charging is desired (topping) repeat steps C, H, and I, with the current adjusted to a lower value (usually $C_1/10$)

J. UPDATE BATTERY RECORDS

Record the charge data in the battery records to ensure good maintenance of the battery (see Appendix B).

K. SWITCH AC POWER OFF

Switch the AC on/off switch off before removing the battery.

NOTE: If in emergency it is required to stop charging, switch the unit to off. When charging is restarted the timer is reset to zero. It may be necessary to adjust the parameters (current and time) before resuming charge.

4 OPERATING GUIDE - DISCHARGING

4.1 DISCHARGE CHARACTERISTICS

The lead-acid and the nickel-cadmium cells are generally assigned nominal open circuit voltages of 2.10 volts and 1.35 volts respectively. Actual open circuit voltage at 75°F/ 25°C for a fully charged battery cell depends on state-of-charge and time after charge.

During discharge, the voltage of the cell or battery immediately begins to decrease because of the effective internal resistance of the cell. This includes the resistance of the terminal posts, active material, plate lugs and grids, separators, and contact resistance between the surface of the active material and the electrolyte. The internal resistance increases during discharge, being greater toward the end of discharge, when the terminal voltage is lower.

As voltage gradually becomes lower during discharge, the point of near exhaustion is reached. At this point, the discharge voltage curve begins to drop very sharply to a value which is of no further practical use. Usually this happens at 18-20 volts for a 24 volt lead-acid battery and 1 volt per cell for a nickel-cadmium battery (see Figure 4–1).

Battery manufacturers specify a cutoff voltage which the battery must exceed during a discharge test to have acceptable capacity. The cutoff voltage varies with the rate of discharge (the discharge current/time combination used to draw the same capacity). For example, the minimum cutoff voltages for a 30 ampere-hour, 24-volt naval aircraft lead-acid storage battery are generally specified as is shown in Table 4- 1.

Rate of Discharge	Discharge Current	Minimum Cutoff Voltage
5 hours	6 amperes	21.0 volts
2 hours	15 amperes	19.2 volts
1 hour	30 amperes	18.0 volts

Table 4- 1 Cutoff voltages at different discharge rates for a 30 ampere-hour, 24 volt lead-acid battery

The specified final minimum cutoff voltage represents the value of voltage at which the rated ampere-hour capacity of the battery must have been delivered for the specified discharge rate. Figure 4–1 is a typical discharge curve for a 40 ampere-hour sealed lead-acid (SLAB) aircraft storage battery discharged at a 1-hour rate of

40 amperes. From Figure 4–1, it is observed that at the end of 1 hour of discharge time, the battery voltage has reduced only to about 22 volts. Because the minimum required cutoff voltage is 18 volts at the 1-hour discharge rate, the battery exceeds the minimum requirements. With increasing hours of use or age, the battery capacity decreases. Therefore, battery manufacturers usually recommend testing for a capacity equal to 80% of the original ampere-hour rating.

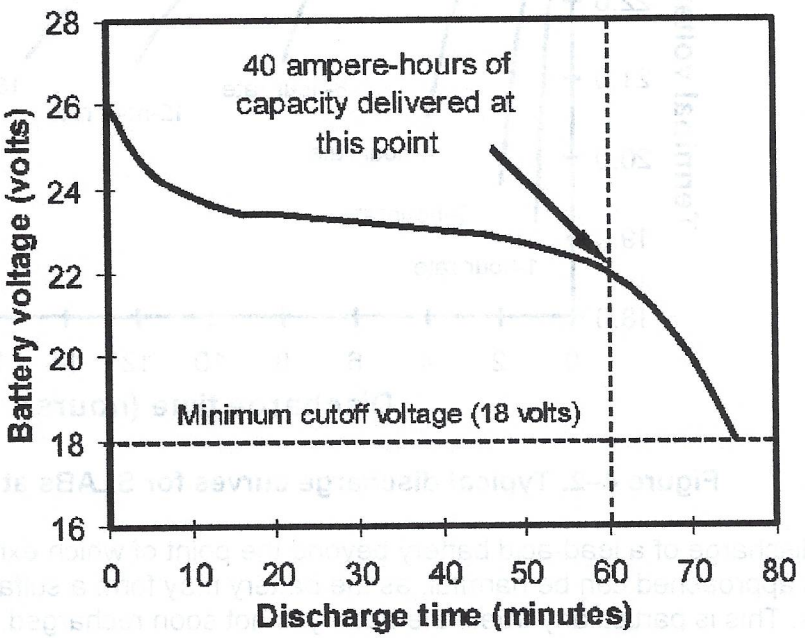


Figure 4–1. Typical discharge curve for 40 ampere-hour lead-acid aircraft battery

Figure 4–2 illustrates discharge curves for typical SLABs at different discharge rates. Note that the cell voltage drops much more rapidly at the higher discharge rates, i.e. the rates at which a greater current is drawn during a shorter period of time.

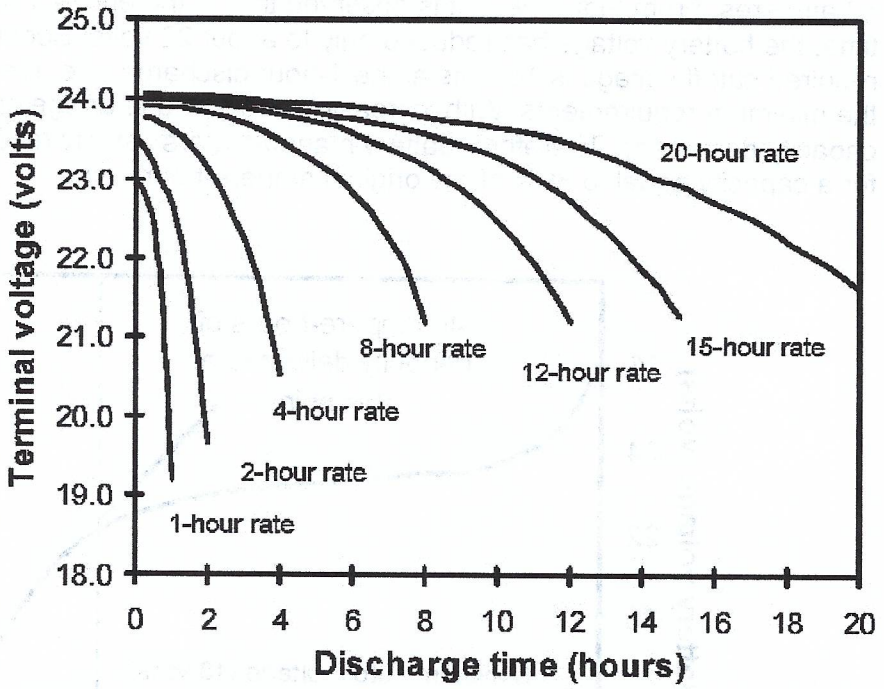


Figure 4–2. Typical discharge curves for SLABs at different rates

The discharge of a lead-acid battery beyond the point of which exhaustion of the cell is approached can be harmful, as the battery may form a sulfate deposit on its plates. This is particularly true if the battery is not soon recharged.

4.2 DISCHARGE CAPACITY TESTING

The purpose of a discharge test is to determine the long-term capacity of the battery. For a lead-acid aircraft battery, for example, the capacity test is the amount of current which can be delivered for one hour or until the voltage decreases to 1.5 volts per cell. This is considered the emergency capacity of the battery. The result of the test will determine whether to accept or reject the battery and which steps could be taken to electrically recondition the battery.

The amount of electrical capacity available from a fully charged nickel-cadmium or lead-acid battery is defined by the capacity rating of the battery and is stated in terms of ampere hours. Because of internal resistance, the higher the discharge rate (higher current during a shorter period of time) demanded of a battery, the less usable capacity it can supply. See Figure 4–2.

4.2.1 Constant-Current Discharge Method

The most accurate and repeatable method of measuring capacity is to discharge the battery at a constant-current rate. This is also the method used by the CA-1550. The load resistance in this method is continuously and automatically varied to maintain a constant discharge current as the battery's voltage decreases. A schematic of the circuit diagram for the CA-1550 can be seen in Figure 4–3. At the end of discharge, the calculation of ampere-hour capacity is the product of discharge current and the elapsed discharge time.

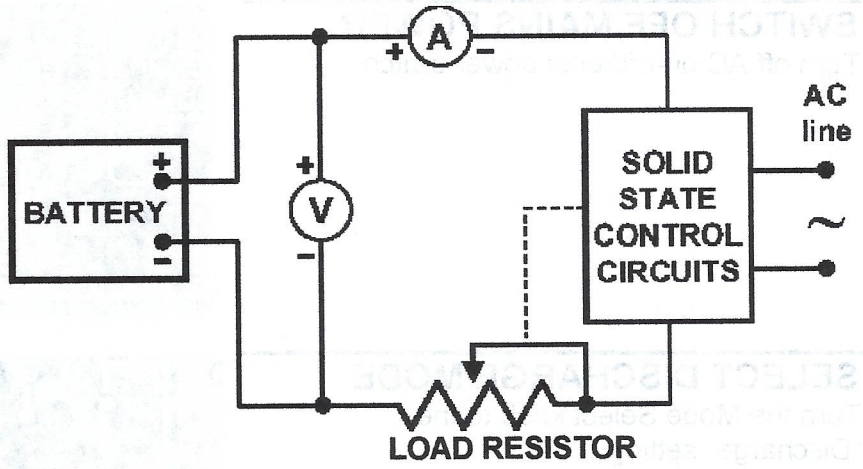


Figure 4–3. Circuit diagram for constant current discharge test

NOTE: Always read the battery manufacturer's operating instructions. Some lead-acid batteries are recommended at a 20 volt cutoff when tested for an hour at 80% of rated capacity. Some nickel-cadmium battery requirements are testing for two hours at half the rated capacity, and a 1 volt per cell cutoff.

4.3 PREPARATION FOR TESTING

Before starting the discharge test, read the component maintenance manual (CMM) or the operating and maintenance manual (OMM) for the specific battery to be tested. Ensure that the discharge rate and cutoff voltage from the battery manufacturer are followed.

It is recommended that a visual inspection of the battery is carried out in conjunction with testing and charging batteries. Samples of Battery Test Records including a visual inspection check lists can be found in Appendix B.

The battery must be fully charged before testing starts, except for special tests.

WARNING: Always turn off the AC power switch before connecting or disconnecting a battery.

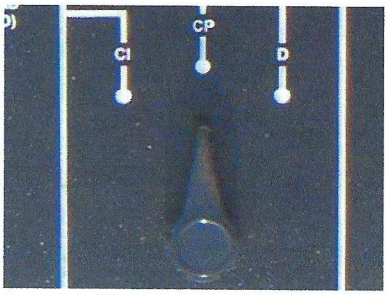
NOTE: The test, unless otherwise specified in the manufacturer's CMM/OMM, shall be conducted at room ambient temperature of 70°F to 85°F (21°C to 29°C).

A. SWITCH OFF MAINS POWER

Turn off AC on-off/reset power switch.

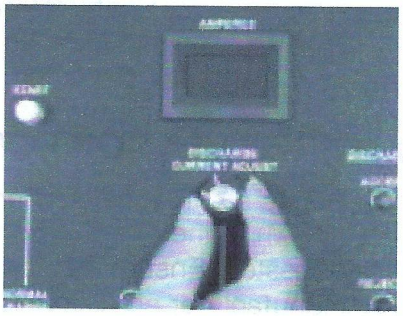
B. SELECT DISCHARGE MODE

Turn the Mode Select knob to the "Discharge" setting.



C. TURN DOWN DISCHARGE CURRENT

Repeatedly turn the Ampere Adjust knob fully counter-clockwise to set discharge current to zero. This prevents excess current, which may be too high for the battery, once the battery is connected and the discharge test has begun.



4.4 DISCHARGE TIME

4.4.1 TIMER UNIT SETTING

The CA-1550 has a built in timer, allowing discharge time settings from 1 to 999 minutes.

4.4.2 DISCHARGE TIME SETTING

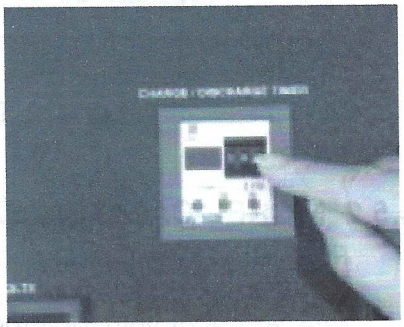
The discharge time is usually set to 60 minutes, after which a pass/reject signal is given based on whether the battery reached the cutoff voltage or not.

To determine the full capacity of the battery a longer time can be set (several hours). The CA-1550 will then continue the discharge test only until the cutoff voltage has been reached. The timer, cutoff voltage and discharge current displays will freeze at this point. The capacity can be calculated as the product of the discharge current and the time passed until the voltage cutoff was reached.

A list of recommended discharge times for the most common batteries can be in Appendix D, but always refer to your battery manufacturer's maintenance manual for the most accurate information.

D. SET TIMER

Set the timer by adjusting the thumb-dial to the required discharge time (usually 60 minutes)



CAUTION. For lead-acid batteries the time and voltage cutoff should be set with caution. If discharge continues too far beyond the point of exhaustion it may be harmful to the battery, unless the battery is soon to be recharged.

4.5 CUTOFF VOLTAGE

The CA-1550 will automatically stop the discharge test when the cutoff voltage has been reached. The cutoff voltage is set so that if the battery voltage is higher than the cutoff voltage when the discharge time has expired, the battery has passed the capacity test.

4.5.1 LEAD-ACID BATTERIES

Always refer to your battery manufacturer's maintenance manual for the most accurate information. For a 24 volt sealed lead-acid battery the cutoff voltage is usually set at 18 or 20 volts when discharged one hour at a current equal to the 80% of the battery's C 1-rate. See Table 4- 2 for examples of discharge test settings for sealed lead-acid batteries. A list of recommended cutoff voltages for the most common batteries can be found in Appendix D

1-hour rating		Discharge settings		
Volts	Ampere hours	Time (min)	Rate (amperes)	Cutoff (volts)
24	10	60	8	18/20
24	15	60	12	18/20
24	20	60	16	18/20
24	30	60	24	18/20
24	40	60	32	18/20
12	10	60	8	9/10
12	15	60	12	9/10
12	20	60	16	9/10
12	30	60	24	9/10
12	40	60	32	9/10

Table 4- 2. Discharge test setting for sealed lead-acid batteries

4.5.2 NICKEL-CADMIUM BATTERIES

For nickel-cadmium batteries the cutoff voltage should equate to an average of 1 volt per cell, when discharge tested at a current of approximately 80% of the C 1 - rate. For a 24 volt/10 ampere-hour battery with 19 cells, the cutoff voltage would be set to 19 volts when discharging at 8 amperes (see Table 4- 3). A list of recommended cutoff voltages for the most common batteries can be in appendix D, but always refer to your battery manufacturer's maintenance manual for the most accurate information.

1-hour rating		Discharge settings		
Volts	Ampere hours	Time (min)	Rate (amperes)	Cutoff (volts)
24	10	60	8	19
24	15	60	12	19
24	20	60	16	19
24	30	60	24	19
24	40	60	32	19
12	10	60	8	10
12	15	60	12	10
12	20	60	16	10
12	30	60	24	10
12	40	60	32	10

Table 4- 3. Discharge test setting for nickel-cadmium batteries

4.5.3 SETTING CUTOFF VOLTAGE ON THE CA-1550

Before setting the cutoff voltage, a battery has to be connected and the unit has to be turned on.

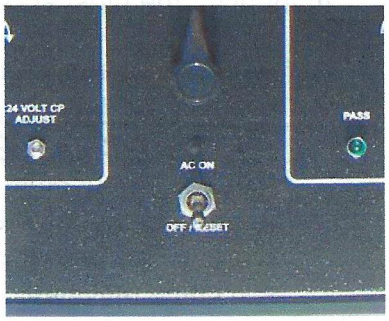
E. CONNECT BATTERY

Connect the battery DC cable to the battery and ensure the connector is plugged in completely.

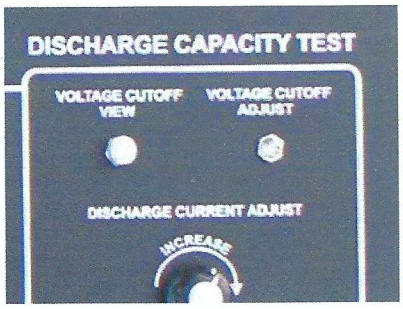
NOTE: The factory-preset 28.5 volts in constant-potential mode can, if desired, be modified in step E.

F. SWITCH ON MAINS POWER

Turn on the AC on-off/reset power switch. An audible alarm sounds, and the Accept lamp illuminates. Meters read all 6's or 8's. The timer reads 0's and its red LED is off. The Discharge Mode Lamp indicator is illuminated.



G. VIEW AND SET CUTOFF VOLTAGE



a. Press and hold the Voltage Cutoff View button. The set cutoff voltage is shown on the voltmeter display.

b. Use a 1/16 inch (2 mm) slot blade precision type screw driver set the Voltage Cutoff Adjust to the desired level.

NOTE: Actual cutoff voltages are slightly lower than the set nominal voltage in order to give the battery an "accept advantage" and allowing the operator to observe a marginal battery and decide its acceptance or rejection. The actual cutoff value also depends on how fast the battery voltage is changing. Of course, the higher the voltage at acceptance, the better the battery.

4.6 SETTING DISCHARGE CURRENT

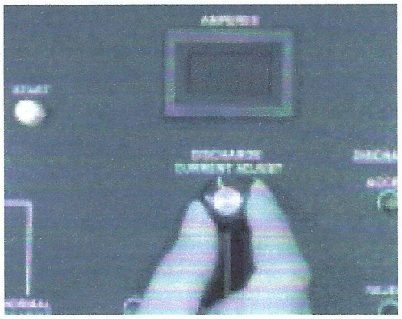
The discharge current in amperes is normally set equal to, or 80% of, the battery nominal 1-hour capacity rating (please refer to the battery manufacturer's maintenance manual). For example, a SLAB battery with a 30 ampere-hour 1-hour capacity rating would be tested with the discharge current set to 24 amperes.

A list of recommended discharge current settings for the most common batteries can be in Appendix C, but always refer to your battery manufacturer's maintenance manual for the most accurate information.

Before setting the discharge current the CA-1550 must have been connected to the battery (see section 4.5) and the AC power switch must have been turned on.

H. SET DISCHARGE CURRENT

Slowly turn the multi-turn Ampere Adjust knob clockwise to the desired discharge current. The ammeter displays the current as it is being adjusted.



NOTE: The current is proceeded with a negative sign indicating that current is being drawn from the battery.

4.7 TEST COMPLETION AND ANALYSIS

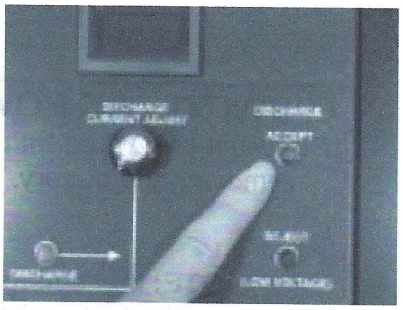
The CA-1550 automatically completes the test with the set parameters. It may however be required to measure the individual cell voltages for nickel-cadmium batteries during the test (see section 4.7.2).

I. WAIT FOR DISCHARGE TEST TO AUTOMATICALLY COMPLETE

During the test the battery voltage, discharge current, and elapsed discharge times are displayed. The voltage will continuously decrease while the current remains constant. The test completes when either the set discharge time or the low cutoff voltage has been reached. An audible alarm sounds and the displays freeze at their final values.

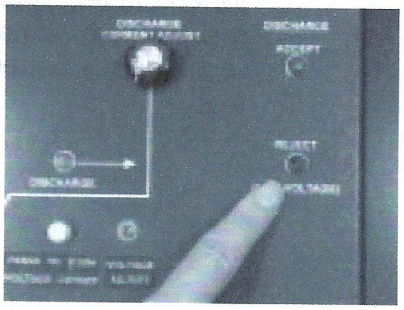
J. 1. IF TEST PASSED

The green Accept lamp illuminates. This indicates the discharge has continued through the duration of the set discharge time (the red LED on the timer is off) without the cutoff voltage being reached. The battery is usually fit for service, after complete recharge. See 4.7.1 and 4.7.2 for respective battery type.



2. IF TEST FAILED

The Reject lamp illuminates if the discharge has been discontinued because the cutoff voltage has been reached before the completion of the set discharge time. The red LED on the timer remains on, but the time is frozen at the elapsed time at which the test failed. The battery is in need of reconditioning or must be rejected for aircraft service. Refer to the battery manufacturer's maintenance manual on how to proceed.



4.7.1 LEAD-ACID BATTERY

If the lead-acid battery has been accepted by the CA-1550 discharge test it has successfully completed the capacity test.

4.7.2 NICKEL-CADMIUM BATTERY

Check each cell with a digital voltmeter near the end of the test.

A. If no cells have dropped below 1.0 volts at the end of the specified time the battery has successfully completed the capacity test.
B. If any cells have dropped below 1.0 volt before or at the end of the capacity test the battery must be reconditioned (deep cycled). Please refer to the battery manufacturer's maintenance manual on how to proceed.

K. UPDATE BATTERY RECORDS.

Record the discharge capacity test data in the battery records to ensure good maintenance of the battery (see Appendix B).

L. SWITCH AC POWER OFF.

Switch the AC on-off/reset switch off before removing the battery.

NOTE: If in emergency it is required to stop the test, switch the unit to off/reset. When the test is restarted the timer is reset to zero. It may be necessary to recharge the battery before resuming the test.

5 CALIBRATION AND MAINTENANCE

5.1 OVERVIEW OF CALIBRATION

The CA-1550 has been calibrated before shipment from the manufacturer. A certificate of calibration with test instruments traceable to the National Institute of Standards and Testing in accordance with MIL-I-45208A has been issued and is enclosed in the back of this manual. Re-calibration is required 12 months after date of first use. To ensure error-free operation over time the unit should be re-calibrated every 12 months depending on usage and changes in surrounding environment.

5.1.1 DIGITAL PANEL METERS

There are two main indicators that need be periodically calibrated: 1) the voltmeter; and 2) the ammeter (see Figure 1–1 in Section 1). The CA 1550 is equipped with two sets of test jacks for easy calibration of these digital display meters. In addition the internal shunt, even though calibrated and certified by the shunt manufacturer, could be verified.

5.1.2 TIMER

The timer is a very accurate crystal-controlled device, not prone to error. It cannot be re-calibrated, but unless an extremely accurate time reading is required, an accurate analog or digital stop watch is adequate to validate its accuracy.

5.1.3 DISCHARGE CURRENT OPERATING RANGE

The CA-1550 discharge current operating range can be modified different than factory-preset 50 amperes discharge current if necessary.

WARNING: Calibration should only be performed by trained personnel. If performed incorrectly it could result in electrical shock leading to injury or death.

5.2 VOLTMETER CALIBRATION

To calibrate the CA-1550 voltmeter, an external calibrated digital voltmeter is required. The unit does not require a battery for this calibration. The circuit diagram for the calibration can be seen in Figure 5–1. The calibration steps are outlined below.

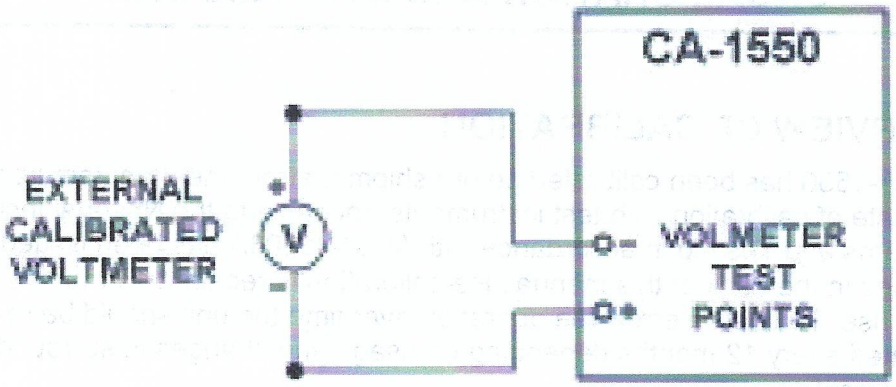


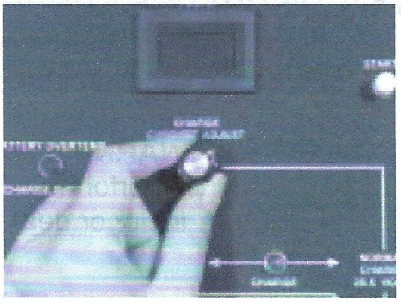
Figure 5–1. Circuit diagram for voltmeter calibration

A. SWITCH OFF MAINS POWER

Turn off the AC on-off/reset power switch.

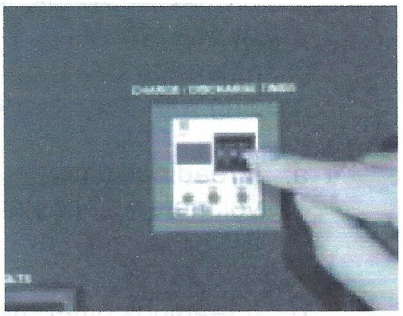
B. SET LOW CHARGE CURRENT

Repeatedly turn the Ampere Adjust knob fully counter-clockwise to set zero. Turn the knob forward a few turn to enable the unit to provide voltage. No current will be drawn as no battery is connected.



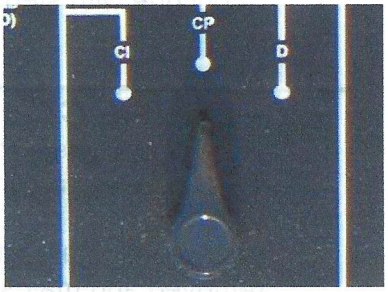
C. SET TIMER

Set the timer by adjusting the thumb-dial to a time that will allow calibration to be completed before the time runs out (for example 60 minutes).



D. SET CONSTANT-POTENTIAL CHARGE MODE

Turn the Mode Select knob to Constant potential, CP.

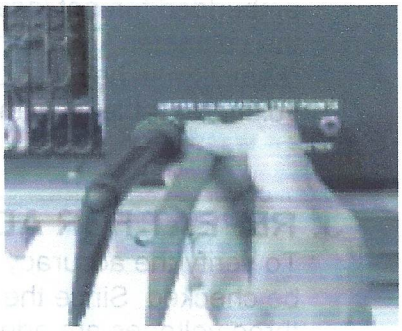


E. SWITCH ON MAINS POWER

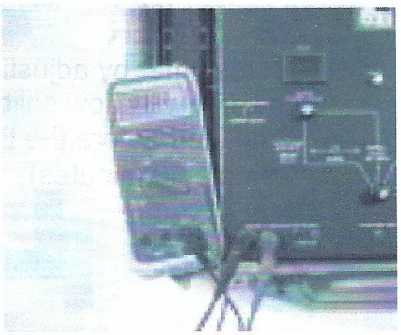
Turn on the AC on-off/reset power switch. The voltmeter reads the set voltage, the ammeter reads zero. The timer reads 0's and its red LED is off. The Charge Mode Lamp indicator is illuminated.

F. CONNECT EXTERNAL VOLTMETER

Set the voltmeter to a DC voltage range appropriate for the set constant potential. Connect the external digital voltmeter into the voltmeter calibration points.



G. COMPARE VOLT READINGS



Compare the CA-1550 digital voltmeter reading with the external calibrated voltmeter.

a. If readings differ less than ± 0.2 volts, the voltmeter is accurately calibrated. Turn AC power off.

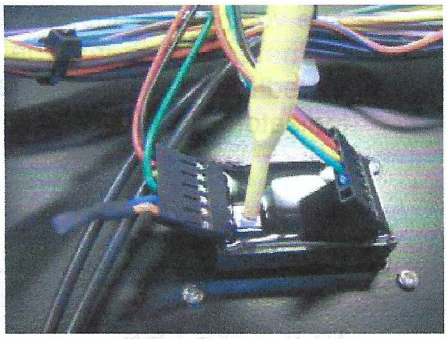
b. If readings differ more than ± 0.2 volts, continue with steps I through K.

H. OPEN THE CA-1550

If voltmeter differs more than ± 0.2 volts, open the front panel of the CA-1550 by removing the two screws on the right side of the panel.

WARNING: Calibration needs to be performed with the unit's cover removed and mains power connected. It should only be performed by trained personnel. If performed incorrectly it could result in electrical shock leading to injury or death.

I. CALIBRATE VOLTMETER



The voltmeter can be found on the back side of the front panel. Locate the voltmeter trimpot.

Using a 1/16 inch (2 mm) slot blade precision type screw driver, adjust the embedded trimpot located at the rear of the voltmeter.Adjust until voltmeter reading matches that of the calibrated voltmeter (at least within ± 0.2 volts).

J. REPEAT FOR ADDITIONAL VOLTAGES

To verify the accuracy over the range of the meter, additional voltages could be checked. Since the CA-1550 digital meters are linear, checking two or three voltages are adequate to verify the range. The easiest way to check an additional voltage is to repeat step H but adjusting the Constant Potential Adjust Trimpot to another voltage (see section 3.5 on how to Modify Constant Potential).

5.3 AMMETER CALIBRATION

To calibrate the CA-1550 ammeter, an external calibrated digital voltmeter, set to the millivolt range, is required as well as a discharged charged battery. The millivoltmeter will read the millivolts dropped across the CA-1550 internal shunt when a charge current is applied. The circuit diagram for the calibration can be seen in Figure 5–2. The calibration steps are outlined below.

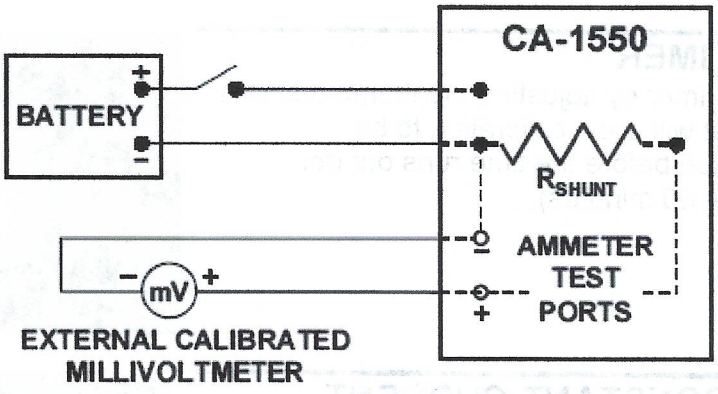
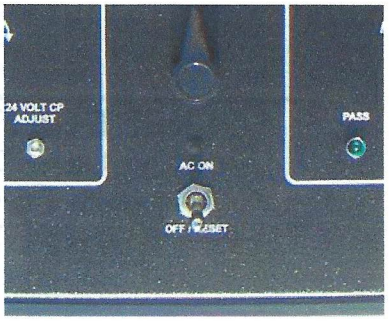


Figure 5–2. Circuit diagram for ammeter calibration

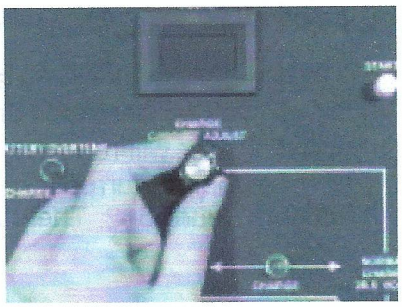
A. SWITCH OFF MAINS POWER

Turn off the AC on-off/reset power switch.



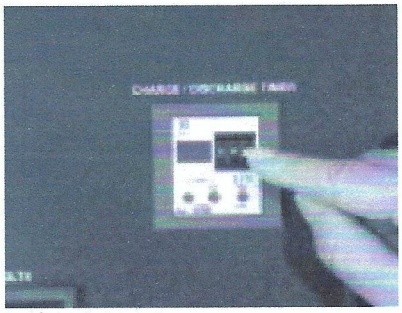
B. TURN DOWN CHARGE CURRENT

Repeatedly turn the Ampere Adjust knob fully counter-clockwise to set charge current to zero.



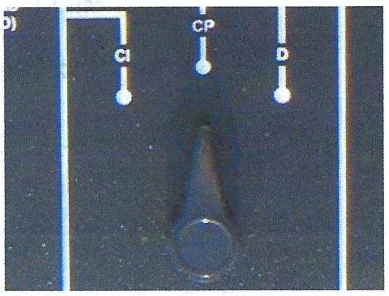
C. SET TIMER

Set the timer by adjusting the thumb-dial to a time that will allow calibration to be completed before the time runs out (for example 60 minutes).



D. SET CONSTANT-CURRENT CHARGE MODE

Turn the Mode Select knob to Constant Current, CI.



E. CONNECT BATTERY

Connect the battery DC cable to the discharged battery. Ensure the connectors are plugged in completely.

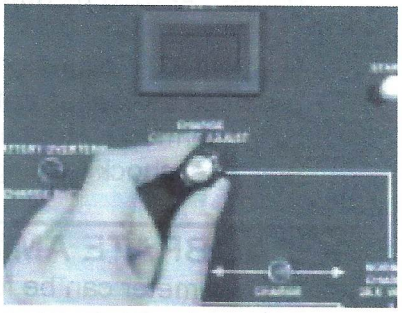
F. SWITCH ON MAINS POWER

Turn on the AC on-off/reset power switch. The voltmeter reads battery terminal voltage, the ammeter reads zero. The timer reads 0's and its red LED is off. The Charge Mode Lamp indicator is illuminated.

G. SET CHARGE CURRENT

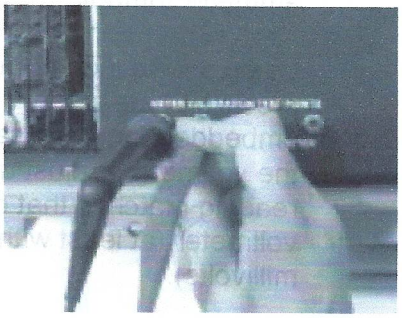
Turn the Ampere Adjust knob until approximately 15 amperes has been reached. The charge current is displayed on the ammeter as the current is being adjusted.

NOTE: If the battery is already significantly charged it may be hard to reach a 15 ampere current.



H. CONNECT EXTERNAL VOLTMETER

Set the voltmeter to a DC millivolt range. Connect the external digital voltmeter into the ammeter calibration points.



I. COMPARE AMPERE READINGS

Compare the CA-1550 digital ammeter reading with the external calibrated millivoltmeter. The external meter reads the millivolt drop across a 50 ampere/50 millivolt shunt. Every millivolt read on the external millivoltmeter represents 1 ampere. The readings should be within ± 0.2 millivolts (amperes).

a. If readings differ <u>less than</u> ± 0.2 millivolts (amperes), the ammeter is accurately calibrated. Turn AC power off and

disconnect battery.

b. If readings differ more than ± 0.2 millivolts (amperes), continue with steps K through M.

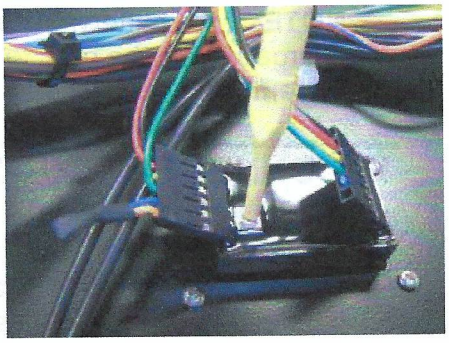
J. OPEN THE CA-1550

If voltmeter differs more than ± 0.2 millivolts (amperes), open the front panel of the CA-1550 by removing the two screws on the right side of the panel.

WARNING: Calibration needs to be performed with the unit's cover removed as well as both mains power and battery connected. It should only be performed by trained personnel. If performed incorrectly it could result in electrical shock leading to injury or death.

K. CALIBRATE AMMETER

The ammeter can be found on the back side of the front panel. Locate the ammeter trimpot.



Using a 1/16 inch (2 mm) slot blade precision type screw driver, adjust the embedded trimpot located at the rear of the voltmeter. Adjust until voltmeter reading matches that of the calibrated voltmeter (at least within ± 0.2 amperes or millivolts).

L. REPEAT FOR ADDITIONAL CURRENT SETTINGS

To verify the accuracy over the range of the meter, additional current settings could be checked. Since the CA-1550 digital meters are linear, checking two or three current settings are adequate to verify the range. The easiest way to check an additional setting is to repeat steps H and J but setting a lower charge current in step H.

5.4 SHUNT VERIFICATION

The CA-1550 internal shunt is calibrated and certified by the shunt manufacturer. The shunt is a linear resistive device consisting of a heavy brass base and heavy manganin (copper alloy) resistance. It is not necessary to calibrate the shunt, however the shunt could be verified with the help of an external calibrated shunt and a millivoltmeter (see Figure 5–3).

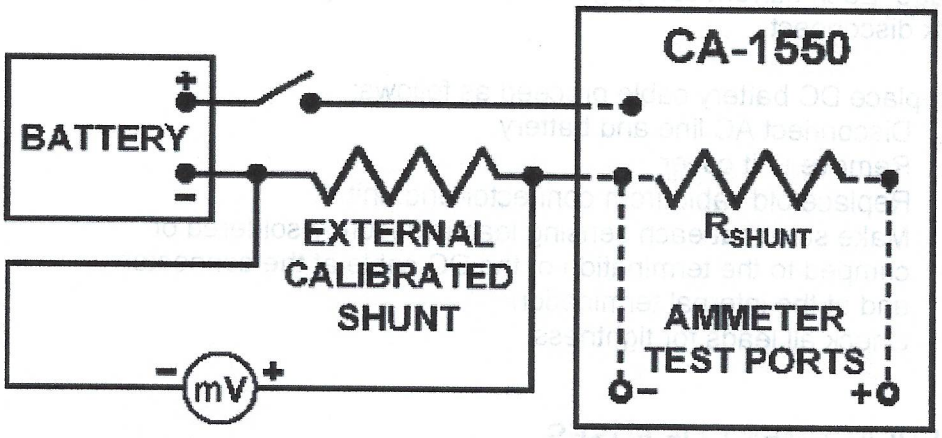


Figure 5–3. Circuit diagram for shunt verification

5.5 DISCHARGE CURRENT OPERATING RANGE

The CA-1550's factory preset max discharge rate of amperes can be increased to 60 amperes. If necessary to increase the discharge rate please contact the factory.

5.6 MAINTENANCE

Standard electrical equipment maintenance and cleaning procedures should be followed.

5.6.1 VENTS AND FAN

Regularly check that the fan vents next to the front panel is clean to ensure adequate cooling of the unit. This is especially important when the unit is placed in a dusty or otherwise dirty air environment.

5.6.2 DC BATTERY CABLE AND LEADS

Inspect DC battery cable and connector periodically. Replace damaged or worn cable.

> **WARNING:** Disconnect AC voltage and battery before attempting to replace or secure cable.

The DC cable contains 4 leads. Two are heavy-gauge DC current leads for the battery discharge current. Two are light-gauge leads for sensing the battery

voltage. Each current carrying lead has its sensing lead attached at the battery quick disconnect.

To replace DC battery cable proceed as follows:

1) Disconnect AC line and battery
2) Remove unit cover
3) Replace old cable from connector and unit
4) Make sure that each sensing lead is securely soldered or crimped to the termination of the DC cable at the connector and at the internal termination
5) Check all leads for tightness

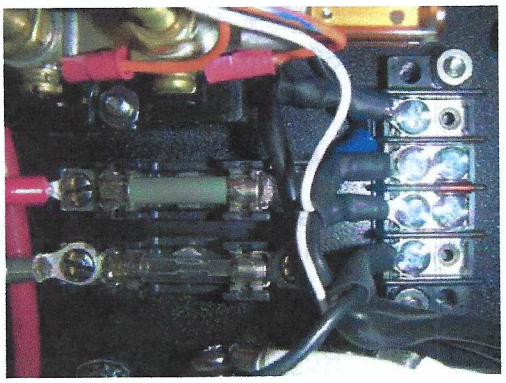
5.6.3 REPLACEMENT OF FUSES

The CA-1550 is equipped with two fuses. One 15 ampere AC line fuse and one 35 ampere DC discharge line fuse. See specification in section 7 for the specific types of fuses required.

WARNING: Disconnect AC voltage and battery before attempting to replace any fuses.

To replace any of the fuses open the front panel of the CA-1550 by removing the two screws on the right side of the panel. Locate the two fuses at the bottom of the unit.

Remove the old fuse from the fuse holder and replace with the new fuse.



5.6.4 CLEANING AGENTS

Do not use acetone and other similar cleaning agents on the meters, timer or any plastic part.

6 TROUBLE-SHOOTING

Problem	Possible Cause	Corrective Action
A. Unit will not turn on	The AC power is not connected to unit	Check AC line with voltmeter
	AC line fuse is blown. May be due to incorrect AC line voltage setting.	Ensure correct AC line voltage setting. (see section 2.1) Replace AC line fuse located on the lower right hand side on the rear of the unit (see section 5.6). Also see step G.
B. Unit turns on but will not start (timing)	Timer is set to zero time, or incorrectly to seconds or low decimal unit.	Increase the timer setting (see section 4.4)
C. Battery voltage reading erratic or not reading	Voltage sensing lead(s) at battery connector loose or broken	Replace or secure leads with both AC voltage and battery disconnected (see section 5.6)
D. Discharge test will not start	Battery is not sufficiently charged to start the test	Recharge battery before retrying discharge test
	Timer is set to zero time, or incorrectly to seconds or low decimal unit.	Increase the timer setting (see section 4.4)
	Cutoff voltage set higher than the actual battery voltage	Reset the cutoff voltage to a lower voltage (see section 4.6) or recharge battery.
	The lead-acid battery is sulfated and will not support a load	Recondition or reject the battery
E. Battery sufficiently charged but discharge test fails immediately as discharge current is increased	High resistance or open circuit in DC cable at Elcon connector, in the cable itself, or in the voltage sensing leads attached to connector	Inspect and measure resistance in DC cable and connector. If high or intermittent high resistance, the cable needs to be replaced
	The lead-acid battery is sulfated	Check all terminals. Set a low discharge current and look for arcing or heat generation.
	The nickel-cadmium battery inter-cell connectors are loose or contaminated causing high resistance	Check all terminals and inter-cell connectors. Set a low discharge current and look for arcing or heat generation.

Problem	Possible Cause	Corrective Action
F. Discharge current immediately surges to a high value and blows DC discharge fuses even though the current adjust knob is set low	Reversed polarity of battery connection	Ensure that polarity is respected on battery connection. If connector has been removed ensure that DC leads are not reversed.
	Defective discharge power control module	With AC voltage and battery disconnected, open unit and remove heavy leads from terminals on black 3"x4" (75mmx50mm) power module. Check resistance between terminals with ohmmeter. If short circuit, call Power Products technical service at (415) 479-5047.
G. The DC charge fuse blown	Reversed polarity of battery connection	Ensure that polarity is respected on battery connection. If connector has been removed ensure that DC leads are not reversed.
	Defective charge power control module	With AC voltage and battery disconnected, open unit and remove ACL leads from terminals on black 2"x2" power module (G1 and G2 tabs included). Check resistance between + and - terminals with ohmmeter. If short circuit, call Power Products technical service at (415) 479-5047.

If trouble cannot be located contact Power Products technical services at (415) 479-5047

7 SPECIFICATIONS

AC Line Input:		115 volts ± 10%, 50/60Hz, 14 amperes or 230 volts ± 10%, 50/60 Hz, 7 amperes (selectable inside unit)
DC Discharge Current:	**Capacity**	0 – 50 amperes adjustable current
	Accuracy	< ± 2% from discharge initiation to cut-off
Constant Current Charge Mode:	**Capacity**	0 – 25 amperes adjustable, 35 volt limit
	Accuracy	< ± 2% from charge initiation to completion
Constant Potential Charge Mode:	**Setting**	Selectable 14.25/28.5 volts, 25 ampere limit
	Accuracy	< ± 2% from charge initiation to completion
Timer:	**Setting**	Adjustable from 0 to 999 units
	Units	Selectable on front of timer between HH.H, MMM, MM.M, SSS, SS.S or S.SS
	Accuracy	< ± 0.1%
Digital Meter Accuracy:	**Voltmeter**	< ± 0.1 volts
	Ammeter	< ± 0.1 amperes
Cooling:		Fan cooled
Housing:		Compact transit case
Outer Dimensions:	**Height**	14 in. (356 mm)
	Depth	15 in. (381 mm)
	Width	10 ¼ in. (260 mm)
AC Line Cord:		AWG 14 3 wire grounded 6 ft long with 115 volt 15 ampere plug User required to change to 230 volt plug
DC Discharge Cable:		4 ft long, terminated in aircraft battery connector
Weight:		Net 53 lbs. (24.1 kg) Shipping 58 lbs. (26.3 kg)
Fuses:	**AC line**	20A/250V, type MDA 1 ¼ x ¼
	Charge line	35A/32V, type AGC 1 ¼ x ¼

APPENDIX A - BATTERY OVERVIEW

CLASSES OF BATTERIES

Batteries can be divided into two major classes: primary and secondary. The primary batteries are not practically reusable once its useful energy has been discharged. The secondary battery is rechargeable. In the following only secondary batteries will be covered.

SECONDARY BATTERIES

Secondary batteries differ from primary batteries in that they may be recharged. Some of the materials in the cells of primary batteries are usually consumed in the process of changing chemical energy into electrical energy. In the secondary system, the materials are transferred from one electrode to the other as the cells discharge. The cells are restored to their original state of charge by forcing an electric current through the cells in a direction opposite to that of the discharge. These batteries are used in a multitude of applications ranging from megawatt sizes in submarines to milliwatt sizes in portable radios.

LEAD-ACID BATTERIES, VENTED OR SEALED (SLAB)

The lead-acid battery is a rechargeable system using acid electrolyte (sulfuric acid and water). Lead-acid batteries may be vented or sealed. The advantages of lead-acid batteries are that they have a low initial cost, require low maintenance, and their discard cost is low. The SLAB, on a per-weight basis, provides as much power as a nickel-cadmium battery. Lead-acid batteries shed active material from the positive plate, proportional to the number of charge/discharge cycles. This results in diminishing battery performance with age and loss of active material on the positive plates due to the washing action of the gas bubbles generated during charge. The open circuit voltage of a fully charged cell is about 2.1-2.2 volts. The discharge voltage is about 2.0 volts and varies with temperature, discharge rate, charge state, and age. The SLAB must be charged in a constant potential mode.

The lead-acid battery is the most widely used of the secondary battery types. Major applications include automobiles, aircraft, aircraft support equipment, and various industrial applications.

NICKEL-CADMIUM BATTERIES

The nickel-cadmium battery is a rechargeable system using alkaline electrolyte (a 31% aqueous solution potassium hydroxide). Nickel-cadmium batteries, which may be vented or sealed, have overcharge capability, high rate charge acceptance and nearly

constant discharge voltage. The disadvantages are the high initial and maintenance costs as well as the cost to discard the battery at the end of life. The open circuit voltage of a fully charged cell is about 1.35 volts. The discharge voltage is about 1.2 to 1.1 volts and varies with temperature, discharge rate, charge state, and age.

Nickel-cadmium batteries are used in auxiliary power units, aircraft engine starting, space satellite power, missile electrical systems, and electrical propulsion

DEFINITIONS

AMPERE-HOURS. The term "ampere-hours" is a unit of measure that refers to the electrical capacity of a battery. It is the product of the current in amperes multiplied by the period of time in hours during which the current is delivered. For example, a battery that discharges at 5.0 amperes for 4.0 hours has delivered 5.0 x 4.0 or 20 ampere-hours. To convert ampere-minutes to ampere-hours, simply divide by 60. E.g. 10 amperes x 40 minutes = 400/60 ampere-hours = 6.6 ampere-hours.

CUTOFF VOLTAGE. The cutoff voltage is the voltage point on the discharge curve, for a specified discharge rate, at which the battery or cell is considered to be discharged for all practical purposes. To discharge beyond this point will yield little useful power due to the subsequent rapid voltage drop that occurs.

CAPACITY RATE (C ,-RATE). The capacity rating of a lead-acid or nickel-cadmium battery is based on a one hour discharge rate with the battery initially at temperature 77.5°F (25°C) and a cutoff terminal voltage of 18.0 volts for a 24-volt battery or 9.0 volts for a 12-volt battery. For example, a 24-volt battery rated at 30.0 ampere-hours should deliver 30.0 amperes for a minimum of 1.0 hours before reaching the 18.0 volts cutoff voltage. This is a one-hour, C ,-rate discharge.

APPENDIX B - BATTERY TEST RECORDS

a. Sealed lead-acid batteries
b. Vented lead-acid batteries
c. Nickel-cadmium batteries (2 pages)

Note: These battery discharge guides are for reference only! Use battery manufacturers specifications for current and voltage cutoff settings.

TEST RECORDS FOR SEALED LEAD-ACID BATTERY

SEALED LEAD-ACID BATTERY TEST RECORD
DATE _____

BASE _____ SQUADRON OR ACTIVITY BATTERY FROM _____
AIRCRAFT BUNO. _____ MFG OF BATTERY _____ TYPE _____
SER NO. _____
LAST DATE BATTERY SERVICED _____

GENERAL CHECKLIST:
1. EXTERNALLY CLEAN AND CORROSION FREE _____
2. CONDITION OF OUTPUT CONNECTOR OK _____
3. HEATER BLANKET TEST OK _____

CHARGING RECORD

1. OPEN-CIRCUIT VOLTAGE _____
2. CHARGING CURRENT _____ AMPERES
3. BATTERY VOLTAGE: (on charge)

(Initial charge) TIME In Hrs	START	2	3	4	5	6	7	8
	____	____	____	____	____	____	____	____
	9	10	11	12	13	14	15	16
	____	____	____	____	____	____	____	____

CAPACITY TEST RECORD

1. DISCHARGE RATE IN AMPERES _____; CUTOFF POTENTIAL _____VOLTS AT END OF ____HRS.
2. PASSED CAPACITY TEST: YES _____; NO _____
3. CAPACITY DISCHARGED AT THE END OF CUTOFF TIME IN AMPERE-HOURS _____

CHARGING RECORD

1. BATTERY VOLTAGE: (on charge)

(Final charge) TIME In Hrs	START	2	3	4	5	6	7	8
	____	____	____	____	____	____	____	____
	9	10	11	12	13	14	15	16
	____	____	____	____	____	____	____	____

LEAKAGE TEST OK AFTER FINAL CHARGE _____

REMARKS: _____

TEST RECORDS FOR VENTED LEAD-ACID BATTERY

LEAD-ACID BATTERY TEST RECORD

DATE _____

BASE _____ SQUADRON OR ACTIVITY BATTERY FROM _____ AIRCRAFT BUNO. _____

MFG OF BATTERY _____ TYPE _____ SER NO. _____

LAST DATE BATTERY SERVICED _____

GENERAL CHECKLIST:

1. EXTERNALLY CLEAN AND CORROSION FREE ☐
2. CONDITION OF OUTPUT CONNECTOR OK ☐
3. CONDITION OF VENT CAPS OK ☐
4. ELECTROLYTE LEVELS OK ☐
5. LEAKAGE TEST LEVELS OK (AFTER CHARGING) ☐

CHARGING RECORD

1. PRECHARGE OPEN-CIRCUIT VOLTAGE _____ _____ (2ND CHARGE)*
2. PRECHARGE TEMPERATURE (CELL NO. 2) _____ °F _____ (2ND CHARGE)*
3. PRECHARGE SPECIFIC GRAVITY OF CELLS FROM POSITIVE END OF BATTERY:

CELL	1	2	3	4	5	6	7	8	9	10	11	12
SPECIFIC GRAVITY												
SPECIFIC GRAVITY												

4. CHARGING VOLTAGE _____ (CONSTANT POTENTIAL METHOD); END OF CHARGE CURRENT _____ (AMPERES)
5. CHARGING CURRENT (CONSTANT CURRENT METHOD); START _____ (AMPERES); FINISH _____ (AMPERES)
6. CHARGING TIME: START RATE, FROM _____ TO _____; FINISH RATE, FROM _____ TO _____
7. TOTAL AMPERE-HOUR INPUT (IF CONSTANT CURRENT METHOD USED)
8. RECORD FOR CHARGE MONITORING

TIME OF READING	CURREN (AMPERES)	BATTERY VOLTAGE	SPECIFIC GRAVITY (CELL NO. 1)	TEMP (CELL NO. 2)	PILOT CELL	
					CELL NO.	SPECIFIC GRAVITY

CAPACITY TEST RECORD

1. DISCHARGE RATE IN AMPERES _____; CUTOFF POTENTIAL _____VOLTS AT END OF _____ HOURS.
2. PASSED CAPACITY TEST: YES ☐; NO ☐
3. CAPACITY DISCHARGED AT THE END OF CUTOFF TIME IN AMPERE-HOURS _____

REMARKS: _____

* FOR USE WHEN CHARGING AFTER CAPACITY TEST

TEST RECORDS FOR NICKEL-CADMIUM BATTERY - P. 1(2)

NICKEL-CADMIUM BATTERY SERVICE RECORD

A. INSPECT FOR CLEAN

1. LOOSE OR CORRODED CONNECTORS
2. LEAKING CELLS
3. DAMAGED VENT CAPS AND O-RINGS
4. DAMAGED HARDWARE
5. OBSTRUCTED CELL AND CONTAINER VENTS
6. CONTAINER AND COVER DAMAGE

1 ☐ BATTERY CONTAINER AND COVER WITH DAMP CLOTH

2 ☐ CONNECTORS AND CELL TOPS WITH NON-METALLIC BRUSH AND AIR HOSE

B. CAPACITY DETERMINATION CHARGE TIME (OPT): START - FINISH

1. FIVE MINUTES PRIOR TO END OF CHARGE, MONITOR ON-CHARGE CELL VOLTAGES INDICATE DISCREPANT CELLS (CIRCLE).

a. HIGH VOLTAGE (ABOVE 1.85 VOLTS)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

b. LOW VOLTAGE (BELOW 1.50 VOLTS)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

2. CELL VOLTAGE BALANCE _____ HIGH CELL _____ VOLTS. LOW CELL _____ VOLTS.

NOTE. 0.35 VOLTS MAXIMUM ALLOWED BETWEEN HIGHEST AND LOWEST VOLTAGE.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

ACTUAL READING OPTIONAL

3. AFTER COMPLETION OF CHARGE, ENSRE THAT THE ELECTROLYTE LEVEL IN EACH CELL IS ABOVE THE CELL BAFFLE. DESTILLED WATER ADDED TO CELL (CIRCLE).

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

C. ELECTRICAL LEAKAGE TEST

2. LEAKAGE CURRENT - _____ MILLIAMPS/ + TERM. TO CASE _____ MILLIAMPS/ - TERM. TO CASE

NOTE. 0.75 MA/RATED AH ALLOWED. IF EXCESSIVE PERFORM STEP D. THEN STEP H.

D. CAPACITY DETERMINATION DISCHARGE TIME (OPT): START FINISH

1. LOW CELL VOLTAGE (LESS THAN 0.95 VOLTS) DURING FIRST HOUR OF DISCHARGE INDICATE LOW CELL. (CIRCLE)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1. CAPACITY TEST YIELD _____ AMPERE-HOURS

NOTE. IF BATTERY REQUIREMENTS OF STEP A, B, C, AND D, PROCEED TO STEP I.

E. CELL EQUALIZATION (IF CELLS MARKED FOR REPLACEMENT)

1. ☐ EQUALIZATION FIXTURE ATTACHED UNTIL BATTERY VOLTAGE READS ZERO.
2. ☐ BATTETY SHORTED MINIMUM OF 16 HOURS.

TIME _____ ON TIME _____ OFF

TEST RECORDS FOR NICKEL-CADMIUM BATTERY - P. 2(2)

F. CHARGE FOLLOWING EQUALIZATION TIME (OPT): START FINISH

1. FIVE MINUTES PRIOR TO END OF CHARGE, MONITOR ON-CHARGE CELL VOLTAGES. INDICATE DISCREPANT CELLS (CIRCLE).

a. HIGH VOLTAGE (ABOVE 1.85 VOLTS)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

b. LOW VOLTAGE (BELOW 1.50 VOLTS)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

2. CELL VOLTAGE BALANCE _____ HIGH CELL _____ VOLTS. LOW CELL _____ VOLTS.

NOTE: 0.35 VOLTS MAXIMUM ALLOWED BETWEEN HIGHEST AND LOWEST VOLTAGE.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

ACTUAL READING OPTIONAL

3. AFTER COMPLETION OF CHARGE, ENSRE THAT THE ELECTROLYTE LEVEL IN EACH CELL IS ABOVE THE CELL BAFFLE. DESTILLED WATER ADDED TO CELL (CIRCLE).

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

G. CAPACITY DISCHARGE FOLLOWING EQUALIZATION TIME (OPT): START FINISH

1. LOW CELL VOLTAGE (LESS THAN 0.95 VOLTS) DURING FIRST HOUR OF DISCHARGE. INDICATE LOW CELL. (CIRCLE)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1. CAPACITY TEST YIELD _____ AMPERE-HOURS

H. CELL DISCHARGE AND DISASSEMBLY (IF CELLS MARKED FOR REPLACEMENT OR CLEANING)

1. EQUALIZATION FIXTURE ATTACHED TO BATTERY MINIMUM OF FOUR HOURS TIME ON _____ TIME OFF _____

2. ☐ DISASSEMBLE BATTERY (REPAIRABLES)

3. ☐ REMOVE DEFECTIVE CELLS. REPLACE WITH NEW OR SERVICABLE CELLS (DISCHARGE TO ZERO VOLTS)

4. ☐ REMOVE DEFECTIVE CELLS. REPLACE WITH NEW OR SERVICABLE CELLS (DISCHARGE TO ZERO VOLTS)

5. ☐ CLEAN AND DRY ALL PARTS

6. ☐ REASSEBLE BATTERY USING PROPER TORQUE VALUES

7. ☐ IF CELLS REPLACED, RETURN TO STEP B.

8. ☐ IF NO CELLS REPLACED PROCEED TO STEP I.

I. FINAL CHARGE (IF NO CELLS MARKED FOR REPLACEMENT) TIME (OPT): START FINISH

1. ☐ CELL VENT CAPS CLEANED AND CONTAINER VENTS CHECKED FOR OBSTRUCTION

2. ☐ CHARGE COMPLETED TIME _____

3. ☐ ELECTROLYTE ADJUSTED TIME _____

4. ☐ INTERCELL AND TERMINAL CONNECTIONS TORQUED TO PROPER VALUES

5. ☐ BATTERY CONTAINER AND COVER PROPERLY MARKED

6. ☐ ELECTRICAL LEAKAGE WITHIN LIMITS (AS PER STEP C)

7. ☐ INTERCELL CONNECTORS COATED WITH CORROSION PREVENTIVE

8. ☐ CELL VOLTAGE BALANCED WITHIN LIMITS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

ACTUAL READING OPTIONAL

REMARKS

DATE SERVICING COMPLETED ☐ BOOST CHARGED OR TRICKLE CHARGED BEFORE ISSUED DATE ISSUED FOR INSTALLATION

CERTIFIED BY (SIGNATURE AND TITLE) DATE

APPENDIX C -BATTERY CHARGE GUIDE

CONCORDE CHARGE GUIDE

Concord aircraft batteries should be charged according to the steps below. The following table is a guide for the most common types. Always refer to the battery manufacturer's maintenance manual for the most accurate information.

a. Remove the battery from the aircraft.
b. Use Power Products CA-1550 Battery Charger/Analyzer or equivalent
c. Charge the battery at Constant Potential (CP). Charge at 14.1 volts for 12 volt batteries or 28.2 volts for 24 volt batteries until the charge current stabilizes for 1 hour (the current usually stabilizes at less than 1 ampere).

Commercial Aircraft – Turbine Starting Series

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
RG-380E/40	12	24	38	to cutoff	30.4	20
RG-380E/44	12	24	42	to cutoff	33.6	20
RG-380E/60	12	24	48	to cutoff	38.4	20
RG-390E	12	24	28	to cutoff	22.4	20
RG-400E	12	24	11	to cutoff	8.8	20
RG-400E/13	12	24	13	to cutoff	10.4	20
RG-45	12	24	12	to cutoff	9.6	20
RG-46	12	24	12	to cutoff	9.6	20
RG-47	12	24	17	to cutoff	13.6	20
RG-91	12	24	22	to cutoff	17.6	20
RG-639	12	24	25	to cutoff	20.0	20
RG-900	12	24	25	to cutoff	20.0	20
RG-445	12	24	18	to cutoff	14.4	20

Commercial Aircraft – Special

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
RG-B1B	12	24	15	to cutoff	12.0	20
RG-6-DOD	12	24	1.5	to cutoff	1.2	20

Commercial Aircraft – Helicopter Series

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
RG-119	12	24	22	to cutoff	17.6	20
RG-206	12	24	17	to cutoff	13.6	20
RG-214	12	24	44	to cutoff	35.2	20
RG-222	12	24	17	to cutoff	13.6	20
RG-265	12	24	26	to cutoff	20.8	20
RG-350	12	24	17	to cutoff	13.6	20
RG-355	12	24	17	to cutoff	13.6	20
RG-407	12	24	27	to cutoff	21.6	20
RG-500	12	24	17	to cutoff	13.6	20
RG-600	12	24	17	to cutoff	13.6	20

Commercial Aircraft – Emergency Power

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
RG-13(NS)	12	24	12	to cutoff	9.6	20
RG-125	12	24	3.5	to cutoff	2.8	20
RG-126	12	24	3.5	to cutoff	2.8	20
RG-128	12	24	3.8	to cutoff	3.0	20
RG-121-1 & -2	12	24	1.5	to cutoff	1.2	20
RG-122-1 & -2	12	24	1.5	to cutoff	1.2	20
RG-123	12	24	10	to cutoff	8.0	20
RG-124	12	24	17	to cutoff	13.6	20
RG-121-3 & -4	12	24	3.3	to cutoff	2.6	20
RG-122-3 & -4	12	24	3.3	to cutoff	2.6	20

Commercial Aircraft – Light Aircraft

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
RG-25	6	12	22	to cutoff	17.6	10
RG-25XC	6	12	26	to cutoff	20.8	10
RG-35A	6	12	31	to cutoff	24.8	10
RG-35AXC	6	12	34	to cutoff	27.2	10
RG24-11	12	24	11	to cutoff	8.8	20
RG24-11M	12	24	11	to cutoff	8.8	20
RG24-15	12	24	13.6	to cutoff	10.9	20
RG24-15M	12	24	13.6	to cutoff	10.9	20
RG24-20	12	24	19	to cutoff	15.2	20

Military Aircraft (SLAB)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
D8565/3-3	12	24	15	cutoff	12.0	20
D8565/4-1	12	24	7.5	cutoff	6.0	20
D8565/5-1	12	24	30	cutoff	24.0	20
D8565/5-2	12	24	30	cutoff	24.0	20
D8565/6-1	12	24	1.5	cutoff	1.2	20
D8565/7-1	12	24	24	cutoff	19.2	20
D8565/7-2	12	24	24	cutoff	19.2	20
D8565/8-1	12	24	15	cutoff	12.0	20
D8565/9-1	12	24	24	cutoff	19.2	20
D8565/9-2	12	24	24	cutoff	19.2	20
D8565/11-1	12	24	10	cutoff	8.0	20
D8565/11-2	12	24	10	cutoff	8.0	20
D8565/13-1	12	24	10	cutoff	8.0	20
D8565/14-1	12	24	15	cutoff	12.0	20
D8565/15-1	12	24	35	cutoff	28.0	20

Commercial Aircraft – General Aviation (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
CB-25	6	12	18	cutoff	14.4	10
CB-35A	6	12	23	cutoff	18.4	10
CB24-11	12	24	10	cutoff	8.0	20
CB24-11M	12	24	10	cutoff	8.0	20
CB24-380E	12	24	45	cutoff	36.0	20
CB24-382E	12	24	40	cutoff	32.0	20
CB24-39E	12	24	25	cutoff	20.0	20
CB24-40E	12	24	14	cutoff	11.2	20

Military Aircraft (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
M83769/1-1	12	24	31	cutoff	24.8	20
M83769/2-1	12	24	18	cutoff	14.4	20
M83769/3-1	12	24	9.5	cutoff	7.6	20
M83769/4-1	12	24	18	cutoff	14.4	20
M83769/5-1	12	24	31	cutoff	24.8	20
M83769/6-1	12	24	31	cutoff	24.8	20

GILL CHARGE GUIDE

GILL aircraft batteries could be charged according to the table below. The table is a guide for the most common types. Always refer to the battery manufacturer's maintenance manual for the most accurate information.

Commercial Aircraft Batteries (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
G-25	6	12	18	24	18.0	10.5
G-35	6	12	23	24	23.0	10.5
G-25M	6	12	18	24	18.0	10.5
G-35M	6	12	23	24	23.0	10.5
G-88	6	12	65	24	65.0	10.5
GE-50C	12	24	31	24	31.0	21.0
GE-50E	12	24	31	24	31.0	21.0
GE-51C	12	24	22	24	22.0	21.0
GE-51E	12	24	22	24	22.0	21.0
GE-54C	12	24	10	24	10.0	21.0
GE-54E	12	24	10	24	10.0	21.0
G-240	12	24	8	24	8.0	21.0
G-241	12	24	8	24	8.0	21.0
G-242	12	24	10	24	10.0	21.0
G-243	12	24	10	24	10.0	21.0
G-244	12	24	18	24	18.0	21.0
G-245	12	24	18	24	18.0	21.0
G-246	12	24	19	24	19.0	21.0
G-247	12	24	19	24	19.0	21.0
G-638E	12	24	37	24	37.0	21.0
G-638C	12	24	37	24	37.0	21.0
G-6381E	12	24	43	24	43.0	21.0
G-6381C	12	24	43	24	43.0	21.0
G-639E	12	24	26	24	26.0	21.0
G-639C	12	24	26	24	26.0	21.0
G-640E	12	24	14	24	14.0	21.0
G-640C	12	24	14	24	14.0	21.0
G-641	12	24	16	24	16.0	21.0

Charge the battery at constant potential 14.1 to 14.3 volts (12 volt battery) or 28.2 to 28.6 volts (24 volt battery) until the current stabilizes for 3 hour (the current usually stabilizes at less than 1 ampere).

Military Spec Batteries (Vented Lead-Acid)

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
M83769/1-1	12	24	31	28.2	Until current stabilizes
M83769/2-1	12	24	18	28.2	Until current stabilizes
M83769/3-1	12	24	8.4	28.2	Until current stabilizes
M83769/4-1	12	24	18	28.2	Until current stabilizes
M83769/5-1	12	24	31	28.2	Until current stabilizes
M83769/6-1	12	24	31	28.2	Until current stabilizes

Military Spec Batteries (SLAB)

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
G-30S	12	24	15	28.2	Until current stabilizes
G-35S	12	24	19	28.2	Until current stabilizes
G-639ES	12	24	24	28.2	Until current stabilizes
G-6381ES	12	24	44	28.2	Until current stabilizes

MARATHON CHARGE GUIDE

For partly discharged batteries go to the second section. For completely discharged batteries, i.e. new batteries, batteries following a capacity test, or deep cycle, begin with the section below.

COMPLETELY DISCHARGED BATTERY

Connect battery to the CA-1550 and charge at the main rate for a **minimum** of 2 1/2 hours and until all cells are 1.55 volts minimum. Do not exceed main charge time of 3 hours.

> **NOTE:** If cell(s) are dry, high cell voltage may occur (1.76 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 2 hours. The electrolyte level should be adjust during the final 15 minutes of the topping. Please refer to the battery's maintenance manual. Upon completion of the topping charge while still on charge, all cell voltages must be from 1.55 volts minimum to 1.75 volts maximum.

- If cell voltages are 1.55 volts to 1.75, the battery is successfully charged.
- If any cell voltage is greater than 1.75 volts, the cell must be replaced. See the battery's maintenance manual
- If any cell voltage rises to 1.55 volts and then decreases below 1.50 volts, the cell must be replaced. See the battery's maintenance manual
- If any cell voltage fails to rise to above 1.50 volts, the cell must be replaced. See the battery's maintenance manual.

PARTIALLY DISCHARGED BATTERY

Connect battery to the CA-1550 and all cells are 1.55 volts or better. This usually takes a short period of time.

> **NOTE:** If cell(s) are dry, high cell voltage may occur (1.76 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. The electrolyte level should be adjust during the final 15 minutes of the topping. Please refer to the battery's maintenance manual. Upon completion of the topping charge, while still on charge, all cell voltages must be from 1.55 volts minimum to 1.75 volts maximum.

- If cell voltages are 1.55 volts to 1.75, the battery is successfully charged.

- If cell voltages are greater than 1.75 volts, one reconditioning cycle should be performed. If cell voltage is greater that 1.75 following the recharge, the cell should be replaced. See the battery's maintenance manual
- If any cell rises to 1.55 volts than decreases below 1.50 volts the cell must be replaced. See the battery's maintenance manual.

CHARGE GUIDE

Below is a guide for constant-current charge settings for the most common Marathon battery types. The suggested settings are for a completely discharged battery.

Marathon Vented Nickel-Cadmium Batteries

		1-hour rating		Charging at Constant Current				
				Main Charge			Topping Charge	
Battery Model	#Cells	Volts	Ampere-hours	Current (amps)	Time (hrs)	Tgt volt (volt)	Current (amps)	Time (hrs)
ATCA21H20	20	24	20	20	2.5 - 3	1.55/cell	11	2.0
ATSP280	20	24	28	28	2.5 - 3	1.55/cell	15	2.0
ATSP-44	20	24	44	44	2.5 - 3	1.55/cell	24	2.0
ATSPP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
BTCA7	19	24	12	12	2.5 - 3	1.55/cell	7.5	2.0
BTMA5	19	24	40	40	2.5 - 3	1.55/cell	21	2.0
BTSP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
CA101	19	22.8	13	10	2.5 - 3	1.55/cell	6.5	2.0
CA103	19	22.8	13	10	2.5 - 3	1.55/cell	6.5	2.0
CA106	19	22.8	13	10	2.5 - 3	1.55/cell	6.5	2.0
CA10N	19	22.8	13	10	2.5 - 3	1.55/cell	6.5	2.0
CA125	19	22.8	3	3	2.5 - 3	1.55/cell	1.8	2.0
CA125-20	20	24	3	3	2.5 - 3	1.55/cell	1.8	2.0
CA126	20	24	3	3	2.5 - 3	1.55/cell	1.8	2.0
CA13	11	13.2	40	40	2.5 - 3	1.55/cell	21	2.0
CA138	11	13.2	38	38	2.5 - 3	1.55/cell	23	2.0
CA139	11	13.2	28	28	2.5 - 3	1.55/cell	15	2.0
CA154	19	22.8	14	13	2.5 - 3	1.55/cell	8.5	2.0
CA154-20	20	24	15	13	2.5 - 3	1.55/cell	8.5	2.0
CA15A	9	10.8	12	12	2.5 - 3	1.55/cell	7.5	2.0
CA15B	10	12	12	12	2.5 - 3	1.55/cell	7.5	2.0
CA16N	20	24	36	40	2.5 - 3	1.55/cell	21	2.0
CA1700	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
CA170A	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
CA176	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
CA20H	19	22.8	20	20	2.5 - 3	1.55/cell	11	2.0
CA20H-20	20	24	20	20	2.5 - 3	1.55/cell	11	2.0
CA21H-1	19	22.8	20	20	2.5 - 3	1.55/cell	11	2.0
CA21H-20	20	24	20	20	2.5 - 3	1.55/cell	11	2.0
CA27	19	22.8	24	24	2.5 - 3	1.55/cell	13.5	2.0
CA27-20	20	24	24	24	2.5 - 3	1.55/cell	13.5	2.0
CA31	19	22.8	3	3	2.5 - 3	1.55/cell	1.8	2.0
CA376	20	24	40	40	2.5 - 3	1.55/cell	21	2.0
CA400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
CA5	19	22.8	36	40	2.5 - 3	1.55/cell	21	2.0
CA51	19	24	5.5	5	2.5 - 3	1.55/cell	3.2	2.0
CA5-20	20	24	36	40	2.5 - 3	1.55/cell	21	2.0
CA53	19	24	5.5	5	2.5 - 3	1.55/cell	3.2	2.0
CA54	19	24	5.5	5	2.5 - 3	1.55/cell	3.2	2.0

Marathon Vented Nickel-Cadmium Batteries (cont.)

		1-hour rating		Charging at Constant Current				
				Main Charge			Topping Charge	
Battery Model	#Cells	Volts	Ampere-hours	Current (amps)	Time (hrs)	Tgt volt (volt)	Current (amps)	Time (hrs)
CA5H	19	22.8	40	40	2.5 - 3	1.55/cell	21	2.0
CA5H-20	20	24	40	40	2.5 - 3	1.55/cell	21	2.0
CA7	19	22.8	13	12	2.5 - 3	1.55/cell	7.5	2.0
CA727-20	20	24	24	24	2.5 - 3	1.55/cell	13.5	2.0
CA727-4	19	22.8	24	24	2.5 - 3	1.55/cell	13.5	2.0
CA727-7	19	22.8	24	24	2.5 - 3	1.55/cell	13.5	2.0
CA727-9	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
CA9	19	22.8	24	24	2.5 - 3	1.55/cell	13	2.0
CA91-20	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
CA9-20	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
GTSP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
KSP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
KTCA21H20	20	24	20	20	2.5 - 3	1.55/cell	11	2.0
MA2-1	19	22.8	65	60	2.5 - 3	1.55/cell	32.5	2.0
MA2-2	19	22.8	65	60	2.5 - 3	1.55/cell	32.5	2.0
MA300H	19	22.8	3	3	2.5 - 3	1.55/cell	1.8	2.0
MA5	19	22.8	40	40	2.5 - 3	1.55/cell	21	2.0
MA500H	19	22.8	5.5	5	2.5 - 3	1.55/cell	3.2	2.0
MA5-20	20	24	40	40	2.5 - 3	1.55/cell	21	2.0
SP138	11	13.2	38	38	2.5 - 3	1.55/cell	23	2.0
SP1700	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
SP170A	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
SP176	20	24	17	17	2.5 - 3	1.55/cell	9	2.0
SP276	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
SP280	20	24	28	28	2.5 - 3	1.55/cell	15	2.0
SP376	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
SP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
SP401	20	24	38	38	2.5 - 3	1.55/cell	23	2.0
SP410	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
SP444-L	20	24	44	44	2.5 - 3	1.55/cell	24	2.0
SP747	20	24	38	38	2.5 - 3	1.55/cell	23	2.0
SP900	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
SP910	20	24	24	24	2.5 - 3	1.55/cell	13	2.0
STMA5	19	22.8	40	40	2.5 - 3	1.55/cell	21	2.0
STMA5-20	20	24	40	40	2.5 - 3	1.55/cell	21	2.0
STSP400	20	24	40	40	2.5 - 3	1.55/cell	23	2.0
STSP930	20	24	24	24	2.5 - 3	1.55/cell	13	2.0

SAFT CHARGE GUIDE

Ground charging of Saft aircraft batteries must always be done with the battery cover removed or with the battery connected to a ventilating system. Otherwise, gas could accumulate in sufficient concentrations to be a potential explosion hazard.

COMPLETELY DISCHARGED BATTERY

To charge a completely discharged battery use one of the following procedures (see Table C- 1):

A. Charge at C /10 amperes until the battery voltage reaches an average of 1.5 volts per cell (30 volts for a 20 cell battery). Then continue charging at this same current rate for 4 additional hours. When following this method, the total charge time must be at least 14 hours, but no more than 16 hours.

B. (1) Charge at C /2 amperes for at least 2 hours. If after this time the battery voltage has not yet reached an average of 1.55 volts per cell (31 volts for a 20 cell battery), continue to charge at this current rate until the voltage rises to this level. However, do not charge at this rate for more than 2 hours and 30 minutes. **(2)** Then charge at C /10 amperes for 4 additional hours.

NOTE: If the battery voltage has not risen in this maximum time see your battery manufacturer's maintenance manual.

Option	Main Charge	End of Charge
A.	C_1/10 amperes until terminal voltage reaches 30 volts Time: Min 10 hrs / Max 12 hrs	C_1/10 amperes for 4 hrs
B.	C_1/2 amperes until terminal voltage reaches 31 volts Time: Min 2 hrs / Max 2 hrs 30 min	C_1/10 amperes for 4 hrs
C.	C_1 amperes until terminal voltage reaches 31.4 volts Time: Min 1 hrs / Max 1 hrs 15 min	C_1/10 amperes for 4 hrs

Table C- 1. Charge options for completely discharged Saft Ni-Cd batteries

C. (1) Charge at C amperes for at least 1 hour. If after this time the battery voltage has not yet reached an average of 1.57 volts per cell (31.4 volts for a 20 cell battery), continue to charger at this current rate until the voltage rises to this level. However, do not charge at this rate for more than 1 hour and 15 minutes. **(2)** Then charge at C /10 amperes for 4 additional hours.

PARTIALLY DISCHARGE BATTERIES

To charge a partially discharged battery following one of the procedures below:

A. If a charged battery has remained inactive for more than 2 weeks, and less than 2 months, before putting it into service it should be charged at a rate of C /10 amperes until the battery voltage reaches an average of 1.50 volts per cell (30 volts for a 20 cell battery).

B. If a charged battery has remained inactive for more than 2 months, or it its exact state of charge is unknown, the battery must be discharged at a rate not to exceed C amperes to a terminal voltage of 1 volt per cell average (20 volts for a 20 cell battery). It should then be recharged following one of the methods indicated in the previous section (Completely Discharged Battery)

CHARGE GUIDE

Below is a guide for constant-current charge settings for the most common Saft battery types. The suggested settings are for a completely discharged battery according to option B in Table C- 1.

"VO" Standard

		1-hour rating		Charging at Constant Current				
				Main Charge			End of Charge	
Battery Model	#Cells	Volts	Ampere-hours	Current (amps)	Time (hrs)	Tgt volt (volt)	Current (amps)	Time (hrs)
19VO3	19	22.8	3	1.5	2 - 2.5	29.5	0.3	4
20VO3	20	24	3	1.5	2 - 2.5	31.0	0.3	4
1201	19	22.8	12	6.0	2 - 2.5	29.5	1.2	4
12101	19	22.8	12	6.0	2 - 2.5	29.5	1.2	4
1600	20	24	16	8.0	2 - 2.5	31.0	1.6	4
2353	19	22.8	23	11.5	2 - 2.5	29.5	2.3	4
2371	20	24	23	11.5	2 - 2.5	31.0	2.3	4
12150	20	24	23	11.5	2 - 2.5	31.0	2.3	4
23180	20	24	23	11.5	2 - 2.5	31.0	2.3	4
23390	20	24	23	11.5	2 - 2.5	31.0	2.3	4
23491	20	24	23	11.5	2 - 2.5	31.0	2.3	4
2500	20	24	25	12.5	2 - 2.5	31.0	2.5	4
2520	20	24	25	12.5	2 – 2.5	31.0	2.5	4
4000A1	20	24	40	20.0	2 – 2.5	31.0	4.0	4
4050A1	20	24	40	20.0	2 – 2.5	31.0	4.0	4
4071	20	24	40	20.0	2 – 2.5	31.0	4.0	4
4080	20	24	40	20.0	2 – 2.5	31.0	4.0	4
40100	20	24	40	20.0	2 – 2.5	31.0	4.0	4
10152	11	13.2	40	20.0	2 – 2.5	17.1	4.0	4

"VHP" Very High Power

Battery Model	#Cells	1-hour rating		Charging at Constant Current				
				Main Charge			End of Charge	
		Volts	Ampere-hours	Current (amps)	Time (hrs)	Tgt volt (volt)	Current (amps)	Time (hrs)
1608	20	24	17	8.5	2 - 2.5	31.0	1.7	4
1658	20	24	17	8.5	2 - 2.5	31.0	1.7	4
2758	20	24	23	11.5	2 - 2.5	31.0	2.3	4
2378	20	24	26	13.0	2 - 2.5	31.0	2.6	4
23578	20	24	26	13.0	2 - 2.5	31.0	2.6	4
26108	20	24	26	13.0	2 - 2.5	31.0	2.6	4
2708	20	24	27	13.5	2 - 2.5	31.0	2.7	4
2778	20	24	27	13.5	2 - 2.5	31.0	2.7	4
27278	20	24	27	13.5	2 - 2.5	31.0	2.7	4
27378	20	24	27	13.5	2 - 2.5	31.0	2.7	4
27478	20	24	27	13.5	2 - 2.5	31.0	2.7	4
3759	20	24	37	18.5	2 - 2.5	31.0	3.7	4
40118	20	24	37	18.5	2 - 2.5	31.0	3.7	4
4059	20	24	37	18.5	2 - 2.5	31.0	3.7	4
4079	20	24	37	18.5	2 - 2.5	31.0	3.7	4
4078	20	24	43	21.5	2 - 2.5	31.0	4.3	4
40208	20	24	43	21.5	2 - 2.5	31.0	4.3	4
40378	20	24	43	21.5	2 - 2.5	31.0	4.3	4
40678	20	24	43	21.5	2 - 2.5	31.0	4.3	4
40678-1	20	24	45	22.5	2 - 2.5	31.0	4.5	4
40678-4	20	24	45	22.5	2 - 2.5	31.0	4.5	4
40878	20	24	45	22.5	2 - 2.5	31.0	4.5	4
4579	20	24	40	20.0	2 - 2.5	31.0	4.0	4

APPENDIX D -BATTERY DISCHARGE GUIDE

CONCORDE DISCHARGE GUIDE

Concord aircraft batteries should be discharge tested according to the steps below. The following table is a guide for the most common types. Always refer to the battery manufacturer's maintenance manual for the most accurate information.

a. Stabilize the battery at 59°F (15°C) or higher. The battery must be at the temperature for at least 24 hours.
b. Discharge the battery at the test rate, or the rate and end point voltage (EPV) specified by the airframe manufacturer, for essential power. Use an end point voltage of 10 volts for 12 volt batteries or 20 volts for 24 volt batteries. If there is no test rate specified use 80% of the C -rate.
c. Record the time to EPV.
d. The battery is acceptable for continuous use if the ampere-hour capacity (actual hours of discharge x ampere rate of discharge) is greater than 85% of the nominal rated capacity (C_1) shown on the label.

Commercial Aircraft – Turbine Starting Series

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
RG-380E/40	12	24	38	28.2	Until current stabilizes
RG-380E/44	12	24	42	28.2	Until current stabilizes
RG-380E/60	12	24	48	28.2	Until current stabilizes
RG-390E	12	24	28	28.2	Until current stabilizes
RG-400E	12	24	11	28.2	Until current stabilizes
RG-400E/13	12	24	13	28.2	Until current stabilizes
RG-45	12	24	12	28.2	Until current stabilizes
RG-46	12	24	12	28.2	Until current stabilizes
RG-47	12	24	17	28.2	Until current stabilizes
RG-91	12	24	22	28.2	Until current stabilizes
RG-639	12	24	25	28.2	Until current stabilizes
RG-900	12	24	25	28.2	Until current stabilizes
RG-445	12	24	18	28.2	Until current stabilizes

Commercial Aircraft – Special

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
RG-B1B	12	24	15	28.2	Until current stabilizes
RG-6-DOD	12	24	1.5	28.2	Until current stabilizes

Commercial Aircraft – Helicopter Series

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
RG-119	12	24	22	28.2	Until current stabilizes
RG-206	12	24	17	28.2	Until current stabilizes
RG-214	12	24	44	28.2	Until current stabilizes
RG-222	12	24	17	28.2	Until current stabilizes
RG-265	12	24	26	28.2	Until current stabilizes
RG-350	12	24	17	28.2	Until current stabilizes
RG-355	12	24	17	28.2	Until current stabilizes
RG-407	12	24	27	28.2	Until current stabilizes
RG-500	12	24	17	28.2	Until current stabilizes
RG-600	12	24	17	28.2	Until current stabilizes

Commercial Aircraft – Emergency Power

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
RG-13(INS)	12	24	12	28.2	Until current stabilizes
RG-125	12	24	3.5	28.2	Until current stabilizes
RG-126	12	24	3.5	28.2	Until current stabilizes
RG-128	12	24	3.8	28.2	Until current stabilizes
RG-121-1 & -2	12	24	1.5	28.2	Until current stabilizes
RG-122-1 & -2	12	24	1.5	28.2	Until current stabilizes
RG-123	12	24	10	28.2	Until current stabilizes
RG-124	12	24	17	28.2	Until current stabilizes
RG-121-3 & -4	12	24	3.3	28.2	Until current stabilizes
RG-122-3 & -4	12	24	3.3	28.2	Until current stabilizes

Commercial Aircraft – Light Aircraft

		1-hour rating		Charging at Constant Potential	
Battery Model	#Cells	Volts	Ampere-hours	Constant potential (volts)	Time (hrs)
RG-25	6	12	22	14.1	Until current stabilizes
RG-25XC	6	12	26	14.1	Until current stabilizes
RG-35A	6	12	31	14.1	Until current stabilizes
RG-35AXC	6	12	34	14.1	Until current stabilizes
RG24-11	12	24	11	28.2	Until current stabilizes
RG24-11M	12	24	11	28.2	Until current stabilizes
RG24-15	12	24	13.6	28.2	Until current stabilizes
RG24-15M	12	24	13.6	28.2	Until current stabilizes
RG24-20	12	24	19	28.2	Until current stabilizes

Military Aircraft (SLAB)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
D8565/3-3	12	24	15	cutoff	12.0	20
D8565/4-1	12	24	7.5	cutoff	6.0	20
D8565/5-1	12	24	30	cutoff	24.0	20
D8565/5-2	12	24	30	cutoff	24.0	20
D8565/6-1	12	24	1.5	cutoff	1.2	20
D8565/7-1	12	24	24	cutoff	19.2	20
D8565/7-2	12	24	24	cutoff	19.2	20
D8565/8-1	12	24	15	cutoff	12.0	20
D8565/9-1	12	24	24	cutoff	19.2	20
D8565/9-2	12	24	24	cutoff	19.2	20
D8565/11-1	12	24	10	cutoff	8.0	20
D8565/11-2	12	24	10	cutoff	8.0	20
D8565/13-1	12	24	10	cutoff	8.0	20
D8565/14-1	12	24	15	cutoff	12.0	20
D8565/15-1	12	24	35	cutoff	28.0	20

Commercial Aircraft – General Aviation (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
CB-25	6	12	18	cutoff	14.4	10
CB-35A	6	12	23	cutoff	18.4	10
CB24-11	12	24	10	cutoff	8.0	20
CB24-11M	12	24	10	cutoff	8.0	20
CB24-380E	12	24	45	cutoff	36.0	20
CB24-382E	12	24	40	cutoff	32.0	20
CB24-39E	12	24	25	cutoff	20.0	20
CB24-40E	12	24	14	cutoff	11.2	20

Military Aircraft (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
M83769/1-1	12	24	31	cutoff	24.8	20
M83769/2-1	12	24	18	cutoff	14.4	20
M83769/3-1	12	24	9.5	cutoff	7.6	20
M83769/4-1	12	24	18	cutoff	14.4	20
M83769/5-1	12	24	31	cutoff	24.8	20
M83769/6-1	12	24	31	cutoff	24.8	20

GILL DISCHARGE GUIDE

A fully charged Gill aircraft battery is considered serviceable if it meets 80% of the 30 minute emergency capacity rating. Connect a fully charged battery to the appropriate load. If after 24 minutes (80% of 30) the battery voltage is at or above 1.75 volts per cell (10.5 volts minimum for 12 volt and 21.0 volts minimum for 24 volt batteries) it is serviceable. Replace the battery if it fails to meet this requirement.

Always refer to the battery manufacturer's maintenance manual for the most accurate information.

Commercial Aircraft Batteries (Vented Lead-Acid)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
G-25	6	12	18	24	18.0	10.5
G-35	6	12	23	24	23.0	10.5
G-25M	6	12	18	24	18.0	10.5
G-35M	6	12	23	24	23.0	10.5
G-88	6	12	65	24	65.0	10.5
GE-50C	12	24	31	24	31.0	21.0
GE-50E	12	24	31	24	31.0	21.0
GE-51C	12	24	22	24	22.0	21.0
GE-51E	12	24	22	24	22.0	21.0
GE-54C	12	24	10	24	10.0	21.0
GE-54E	12	24	10	24	10.0	21.0
G-240	12	24	8	24	8.0	21.0
G-241	12	24	8	24	8.0	21.0
G-242	12	24	10	24	10.0	21.0
G-243	12	24	10	24	10.0	21.0
G-244	12	24	18	24	18.0	21.0
G-245	12	24	18	24	18.0	21.0
G-246	12	24	19	24	19.0	21.0
G-247	12	24	19	24	19.0	21.0
G-638E	12	24	37	24	37.0	21.0
G-638C	12	24	37	24	37.0	21.0
G-6381E	12	24	43	24	43.0	21.0
G-6381C	12	24	43	24	43.0	21.0
G-639E	12	24	26	24	26.0	21.0
G-639C	12	24	26	24	26.0	21.0
G-640E	12	24	14	24	14.0	21.0
G-640C	12	24	14	24	14.0	21.0
G-641	12	24	16	24	16.0	21.0

MARATHON DISCHARGE GUIDE

If following a charge, and 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.
- Crate for 60 minutes minimum for new batteries.

OR

- C/2 rate for 120 minutes - 100% capacity requirement to minimum acceptable end voltage of 1.0 volts per cell for in-service batteries.
- C/2 rate for 135 minutes minimum for new batteries.

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

If any cells have dropped below 1.0 volt before the end of the specified capacity test time, do not stop discharge. The battery must be reconditioned (deep cycled).

Marathon Vented Nickel-Cadmium Batteries

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
ATCA21H20	20	24	20	51	20	20
ATSP280	20	24	28	51	28	20
ATSP-44	20	24	44	51	44	20
ATSPP400	20	24	40	51	40	20
BTCA7	19	24	12	51	12	19
BTMA5	19	24	40	51	40	19
BTSP400	20	24	40	51	40	20
CA101	19	22.8	13	51	13	19
CA103	19	22.8	13	51	13	19
CA106	19	22.8	13	51	13	19
CA10N	19	22.8	13	51	13	19
CA125	19	22.8	3	51	3	19
CA125-20	20	24	3	51	3	20
CA126	20	24	3	51	3	20
CA13	11	13.2	40	51	40	11
CA138	11	13.2	38	51	38	11
CA139	11	13.2	28	51	28	11
CA154	19	22.8	14	51	14	19
CA154-20	20	24	15	51	15	20
CA15A	9	10.8	12	51	12	9
CA15B	10	12	12	51	12	10
CA16N	20	24	36	51	36	20
CA1700	20	24	17	51	17	20

Marathon Vented Nickel-Cadmium Batteries (cont)

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
CA170A	20	24	17	51	17	20
CA176	20	24	17	51	17	20
CA20H	19	22.8	20	51	20	19
CA20H-20	20	24	20	51	20	20
CA21H-1	19	22.8	20	51	20	19
CA21H-20	20	24	20	51	20	20
CA27	19	22.8	24	51	24	19
CA27-20	20	24	24	51	24	20
CA31	19	22.8	3	51	3	19
CA376	20	24	40	51	40	20
CA400	20	24	40	51	40	20
CA5	19	22.8	36	51	36	19
CA51	19	24	5.5	51	5.5	19
CA5-20	20	24	36	51	36	20
CA53	19	24	5.5	51	5.5	19
CA54	19	24	5.5	51	5.5	19
CA5H	19	22.8	40	51	40	19
CA5H-20	20	24	40	51	40	20
CA7	19	22.8	13	51	13	19
CA727-20	20	24	24	51	24	20
CA727-4	19	22.8	24	51	24	19
CA727-7	19	22.8	24	51	24	19
CA727-9	20	24	24	51	24	20
CA9	19	22.8	24	51	24	19
CA91-20	20	24	24	51	24	20
CA9-20	20	24	24	51	24	20
GTSP400	20	24	40	51	40	20
KSP400	20	24	40	51	40	20
KTCA21H20	20	24	20	51	20	20
MA2-1	19	22.8	65	120	32.5	19
MA2-2	19	22.8	65	120	32.5	19
MA300H	19	22.8	3	51	3	19
MA5	19	22.8	40	51	40	19
MA500H	19	22.8	5.5	51	5.5	19
MA5-20	20	24	40	51	40	20
SP138	11	13.2	38	51	38	11
SP1700	20	24	17	51	17	20
SP170A	20	24	17	51	17	20
SP176	20	24	17	51	17	20
SP276	20	24	24	51	24	20
SP280	20	24	28	51	28	20
SP376	20	24	40	51	40	20
SP400	20	24	40	51	40	20
SP401	20	24	38	51	38	20
SP410	20	24	40	51	40	20
SP444-L	20	24	44	51	44	20
SP747	20	24	38	51	38	20
SP900	20	24	24	51	24	20
SP910	20	24	24	51	24	20
STMA5	19	22.8	40	51	40	19
STMA5-20	20	24	40	51	40	20
STSP400	20	24	40	51	40	20
STSP930	20	24	24	51	24	20

SAFT DISCHARGE GUIDE

Discharge the battery at a rate not to exceed C_A amperes (for example 40 amperes for a 40 ampere-hour battery). Record the time at the start of the discharge and the discharge current. Monitor the cell voltages periodically during the discharge. Record the time at which the first cell reaches 1.0 volt. It is not a cause for concern if a cell goes to zero volts or reverse polarity during battery discharge. Simply short out such cell's terminals for the remainder of the discharge. Stop the discharge, and record the time when the battery terminal voltage corresponds to 1.0 volt per cell (20 volts for a 20 cell battery).

Calculate the elapsed time T_A required to discharge the first cell to 1.0 volt and the elapsed time T_B required to discharge the battery to an average of 1.0 volts per cell.

With the above information make the following calculations:

- Minimum cell capacity C_A = T (in hours) x Discharge current
- Battery capacity C_B = T (in hours) x Discharge current

If the minimum cell capacity C_A is greater than 85% (100% for VHP batteries) of the rated capacity of the battery (C_B will in this case also be greater than 85% of rated capacity), the battery can be placed back into service.

If the minimum cell capacity C_A is less than 85% (100% for VHP batteries) of the rated capacity the battery should be given a deep cycle and recharged.

"VO" Standard

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
19VO3	19	22.8	3	to cutoff	3	19
20VO3	20	24	3	to cutoff	3	20
1201	19	22.8	12	to cutoff	12	19
12101	19	22.8	12	to cutoff	12	19
1600	20	24	16	to cutoff	16	20
2353	19	22.8	23	to cutoff	23	19
2371	20	24	23	to cutoff	23	20
12150	20	24	23	to cutoff	23	20
23180	20	24	23	to cutoff	23	20
23390	20	24	23	to cutoff	23	20
23491	20	24	23	to cutoff	23	20
2500	20	24	25	to cutoff	25	20
2520	20	24	25	to cutoff	25	20
4000A1	20	24	40	to cutoff	40	20
4050A1	20	24	40	to cutoff	40	20
4071	20	24	40	to cutoff	40	20
4080	20	24	40	to cutoff	40	20
40100	20	24	40	to cutoff	40	20
10152	11	13.2	40	to cutoff	40	11

"VP" Low Impedance

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
605	19	22.8	6	to cutoff	6	19
616	20	24	6	to cutoff	6	20
1277	19	22.8	14	to cutoff	14	19
12777	19	22.8	15	to cutoff	15	19
1656	20	24	15	to cutoff	15	20
16156	20	24	15	to cutoff	15	20
16256	20	24	15	to cutoff	15	20
16356	20	24	15	to cutoff	15	20
1606	20	24	16	to cutoff	16	20
16556	20	24	16	to cutoff	16	20
1756	20	24	17	to cutoff	17	20
2026	20	24	22	to cutoff	22	20
20126	20	24	22	to cutoff	22	20
2376	20	24	22	to cutoff	22	20
23176	20	24	22	to cutoff	22	20
23186	20	24	22	to cutoff	22	20
23376	20	24	22	to cutoff	22	20
23476	20	24	22	to cutoff	22	20
23576	20	24	22	to cutoff	22	20
23676	20	24	22	to cutoff	22	20
2386-1	20	24	22	to cutoff	22	20
2506	20	24	23	to cutoff	23	20
25106	20	24	23	to cutoff	23	20
40253	11	13.2	36	to cutoff	36	11
40353	11	13.2	42	to cutoff	42	11
4006A	20	24	36	to cutoff	36	20
40206	20	24	36	to cutoff	36	20
4076	20	24	36	to cutoff	36	20
4076-11	20	24	40	to cutoff	40	20
4076-13	20	24	40	to cutoff	40	20
40153	11	13.2	36	to cutoff	36	11
40176	20	24	36	to cutoff	36	20
40376	20	24	36	to cutoff	36	20
401176	20	24	40	to cutoff	40	20
40576	20	24	36	to cutoff	36	20
40676	20	24	36	to cutoff	36	20
40776	20	24	40	to cutoff	40	20
5103	22	26.4	50	to cutoff	50	22

"VHP" Very High Power

		1-hour rating		Capacity Test		
Battery Model	#Cells	Volts	Ampere -hours	Discharge time (min)	Discharge current (amperes)	Cutoff voltage (volts)
1608	20	24	17	to cutoff	17	20
1658	20	24	17	to cutoff	17	20
2758	20	24	23	to cutoff	23	20
2378	20	24	26	to cutoff	26	20
23578	20	24	26	to cutoff	26	20
26108	20	24	26	to cutoff	26	20
2708	20	24	27	to cutoff	27	20
2778	20	24	27	to cutoff	27	20
27278	20	24	27	to cutoff	27	20
27378	20	24	27	to cutoff	27	20
27478	20	24	27	to cutoff	27	20
3759	20	24	37	to cutoff	37	20
40118	20	24	37	to cutoff	37	20
4059	20	24	37	to cutoff	37	20
4079	20	24	37	to cutoff	37	20
4078	20	24	43	to cutoff	43	20
40208	20	24	43	to cutoff	43	20
40378	20	24	43	to cutoff	43	20
40678	20	24	43	to cutoff	43	20
40678-1	20	24	45	to cutoff	45	20
40678-4	20	24	45	to cutoff	45	20
40878	20	24	45	to cutoff	45	20
4579	20	24	40	to cutoff	40	20

WARRANTY

1 YEAR WARRANTY

POWER PRODUCTS warrants its products to be free from defects in workmanship and material for a one year period from the date of shipment to the distributor, original equipment manufacturer (OEM), or original end user. If any product shall prove to be defective during the warranty period, POWER PRODUCTS will repair or replace such part.

There are no warranties which extend beyond the description on the face hereof. This warranty is in lieu of all other warranties, express or implied. POWER PRODUCTS excludes liability for incidental and consequential damages.

An action for breach of this warranty must be commenced within one year after the breach is or should have been discovered.

POWER PRODUCTS specifically disclaims all other representations to the first user/ purchaser, and all other obligations or liabilities. No person is authorized to give any other warranties or to assume any liabilities on POWER PRODUCTS' behalf.

CERTIFICATION OF CALIBRATION

BATTERY CHARGER / ANALYZER - MODEL CA-1550

APPLICATION: Charging and discharge testing of 12 or 24 volt lead-acid or nickel-cadmium aircraft batteries. Charging in either constant-potential or constant-current mode.

SPECIFICATIONS:

- AC input 115 or 230 VAC ±10% 50/60 Hz -selectable
- Control knob adjustment for charge and discharge currents
- Adjustable discharge voltage cutoff, for 12 and 24 volt lead-acid batteries and from single cell to 24 volt nickel-cadmium batteries
- Adjustable charge current in constant-current charging mode
- Adjustable voltage in constant-potential charging mode
- Meter reading accuracy: Voltmeter ± 0.1 volts
  Ammeter ± 0.1 amperes
  Timer 0.1% of preset time

NOTES:

A. Unit manufactured and calibrated under MIL-I-45208

B. Calibrating instruments used:

- Meter: FLUKE Model 8010A & 73III DC volts
  DC mV
- Shunt: EMPRO Standard 0.25%
- V/MV standard, EPPLY LABS Standard Cell
- Digital Timer, Calibrated Standard

UNIT:	BATTERY CHARGER / ANALYZER
MODEL:	CA-1550
SERIAL #:	_____
CALIBRATION DUE:	ONCE A YEAR
SHIPPED CONDITION:	_____ CALIBRATED / IN TOLERANCE -PASSED
PROCEDURE:	33K6-4-2193-1
ENVIRONMENTAL CONDITIONS:	74°F 38% R.H.
DATE OF FIRST USE:	_____

Power Products Inc. certifies that the above listed instrument meets or exceeds all published specifications. It has been calibrated using Standard MIL-I45208 whose accuracies are traceable to the National Institute of Standards and Technology.

DATE MANUFACTURED: _____ S/N: _____

SIGNATURE: _____

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info@power-products.com

INDEX

ADVANCED POWER PRODUCTS

INVOICE

955 TODD STREET

AZUSA, CA 91702

INVOICE NO: 25779

Page 1 of 1

INVOICE DATE: 3/13/06

Sold To:
CASH

Ship To:
COOPER TIRE AND RUBBER
701 LIMA AVE
FINDLAY OH 45840

PO Number	Ship Date	Shipped Via	Terms	F.O.B.	Order No.
00001	3/13/06	UPS	CASH	AZUSA	16842-00

Ordered	Shipped	Item No.	Description	Price	Amount
1	1	4159	CHARGER/ANALYZER	4076.00	4,076.00
				SUBTOTAL	4,076.00
				INVOICE TOTAL	4,076.00

NOTE:
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PD VISA

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