

CENTRAL OFFICE AND PABX BATTERIES
METHOD OF DETERMINING RESERVE CAPACITY

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1. GENERAL

1.01 This section contains instructions for determining the reserve capacity of a central office or PABX battery cell without removing the cell from the battery string. These instructions are based upon the assumption that the cell remains on regular float charge throughout these tests.

1.02 To justify the scrapping of a storage cell, all evidence of deterioration, as indicated by visual inspection (Section 205-010-301 readings, taken by special test equipment such as a discharge tester, specific gravity readings, and cell voltage readings from battery records should be compiled into an accurate analysis of battery condition. Age alone is not a satisfactory criterion for scrapping a battery.

1.03 The model AP300A2 Portable Discharger/Recharger is used for the tests contained in this section. (Refer to Section 108-850-I 00 for additional information on the model AP300A2 Portable Discharger/Recharger.) Discharge tests are not required on a regular basis, but they should be performed under the following conditions:

- (a) During the installation of a new battery, if the voltage or specific gravity is abnormal after the freshening charge, or if there are visual indications of trouble.

- (b) Prior to installation of a used battery.

NOTE: All record sheets should accompany a used battery, and the battery must be equalized prior to testing.

- (c) When voltage and specific gravity readings indicate deterioration.

- (d) If cells are old and gassing heavily on float charge.

- (e) When cells are nearing the end of the manufacturer's estimated life.

- (f) When doubt exists concerning the ability of the battery to carry the office load for the engineered reserve.

- (g) When retest is required where cells are near retirement capacity.

1.04 In the process of determining the reserve capacity of a central office or PABX battery:

- (a) More than one cell should be tested to determine the average capacity of the whole battery.

- (b) When end cells are included, at least one of these should be tested.

- (c) Cells with the lowest specific gravity on both the lower and upper tiers of the battery rack should be tested to check cells with different temperatures. (Cells on the top tier will have higher ambient temperature than cells closer to the floor.)

1.05 This section has been reissued to incorporate changes and additions primarily related to battery cell types and charging rates. Due to the extent of the changes required, marginal arrows have been omitted. Remove and destroy all copies of Section 205-010-502, Issue 2.

2. TEST EQUIPMENT REQUIRED

2.01 Performance of tests contained in this section requires the following test equipment:

- (a) Discharger/Recharger, Model AP300A2.

NOTE: For a description of, and maintenance and troubleshooting instructions for the Model AP300A2 Discharger/ Recharger, refer to the appropriate sections in the 108-850 series of GTE Practices.

- (b) Paper, Chart (furnished with the discharger/recharger)
- (c) Hydrometer, V-Z-F
- (d) Thermometer, battery, vent
- (e) Voltmeter, dc, 931 or equivalent

3. TESTS

Preparing for Tests

3.01 To prepare the Model AP300A2 Discharger/ Recharger for testing a cell to determine its reserve capacity:

- (1) Check that all switches on the control panel (Figure 1) are in the OFF or NORMAL position. If it is necessary to set the programmer control to OFF, turn it in the clockwise direction only.
- (2) Connect the 12-foot length of red 4/0 gauge welding cable to the terminal stud marked POS (Figure 2). Connect the 12-foot length of black 4/0 gauge welding cable to the terminal stud marked NEG (Figure 2).

CAUTION: Always connect the cables to the discharger/recharger before

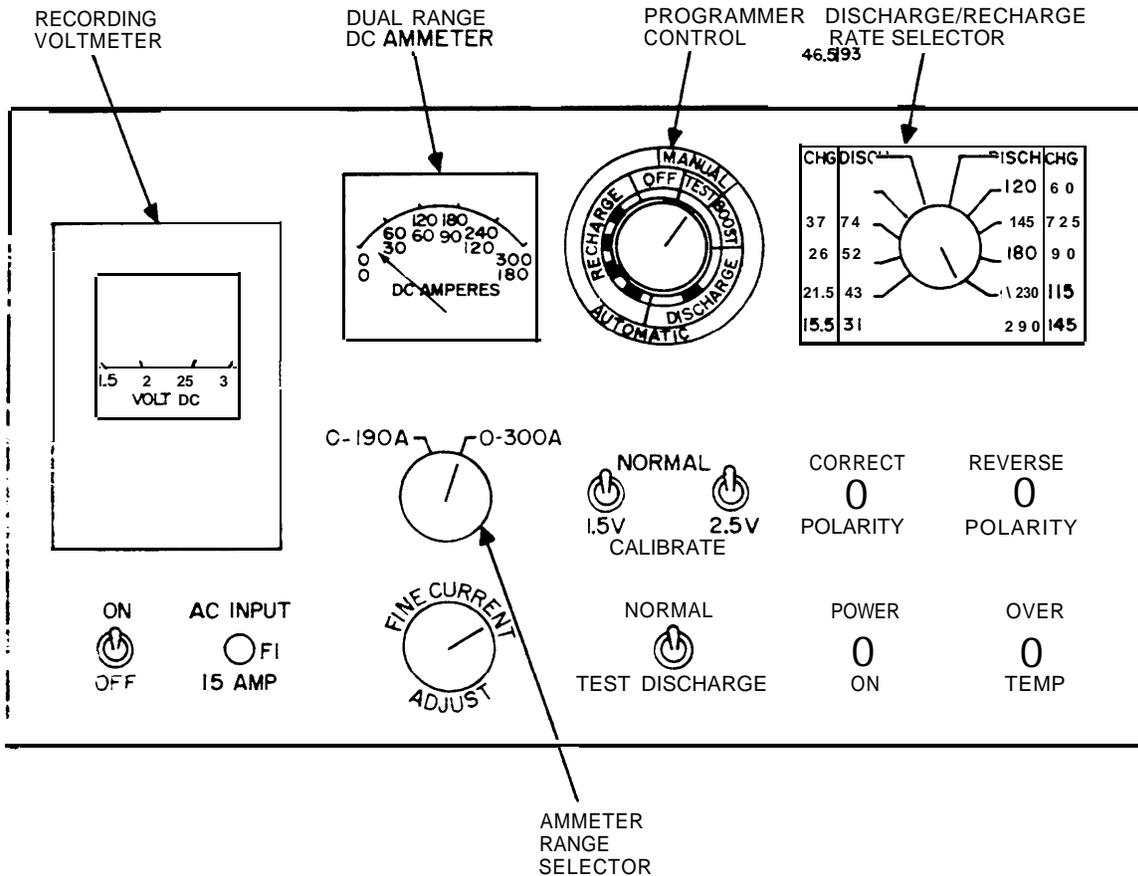


Figure 1 Control Panel of Model AP300A2 Discharger/Recharger,

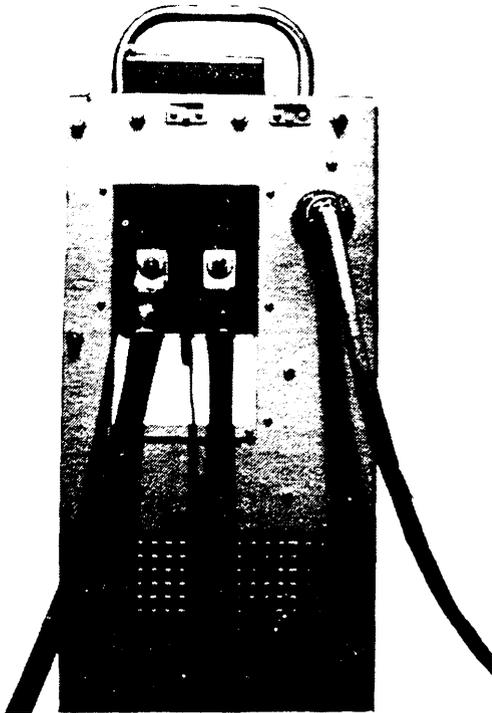


Figure 2. Discharger/Recharger with Power and Reference Leads Attached.

connecting them to the cell to be tested.

- (3) Connect the red and black 18 gauge reference leads to the positive and negative external terminals, respectively (Figure 2).

Lead-Calcium Cells

3.02 To test a lead-calcium type cell for reserve capacity :

- (1) Prepare the discharger/recharger for use as instructed in Paragraph 3.01.
- (2) Initiate a Form S 4209 Single Cell Discharge Test Record (Figure 3) as follows:
 - (a) Enter the appropriate information in the TEST DATE, TESTED BY, OFFICE, LOCATION CODE, and REASON FOR TESTING spaces.
 - (b) Complete the CELL DATA sec-

tion by inserting the appropriate information in each space.

- (c) Using the hydrometer, measure the specific gravity of the cell to be tested. Enter the results in the SPECIFIC GRAVITY space in the PRE-TEST CONDITIONS section.
 - (d) Using the 931 voltmeter, measure the voltage of the cell to be tested. Enter the results in the CELL VOLTAGE space in the PRE-TEST CONDITIONS section.
 - (e) Using the battery vent thermometer, measure the temperature of the cell to be tested. Enter the results in the CELL TEMPERATURE space in the PRE-TEST CONDITIONS section.
 - (f) Using the results of step 2e, refer to Table 1 to determine the temperature correction factor. Enter the result in the TEMP. CORR. FACTOR space in the PRE-TEST CONDITIONS section.
 - (g) Enter the room temperature in the ROOM TEMPERATURE space in the PRE-TEST CONDITIONS section.
 - (h) In the TEST EQUIPMENT AND ADJUSTMENT SECTION, enter the make, model number, and serial number in the appropriate spaces.
- (3) Using bolts, nuts, and washers as shown in Figures 4 and 5, connect the 4/0 gauge cables of the discharger/recharger to the cell terminals as follows:
 - (a) Connect the red cable to the positive terminal.
 - (b) Connect the black cable to the negative terminal.

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FORM S 4209 (6/71)
GTEP 205 - 010 - 502

SINGLE CELL DISCHARGE TEST RECORD

TEST DATE	OFFICE
TESTED BY	LOCATION CODE

REASON FOR TEST

CELL DATA		PRE - TEST CONDITIONS	
BATTERY		SPECIFIC GRAVITY	
STRING NO.		CELL VOLTAGE	
CELL NO.		CELLTEMPERATURE	°F
MANUFACTURE		TEMP. CORR. FACTOR	
CAT. NO.		ROOM TEMPERATURE	°F
8 HOUR CAPACITY	A.H.	AFTER TEST CONDITIONS	
DATE MANUFACTURED		SPECIFIC GRAVITY	
DATE INSTALLED		CELLVOLTAGE	
		CELLTEMPERATURE	°F

TEST EQUIPMENT AND ADJUSTMENT			
TESTER: MAKE	MODEL NO	SERIAL NO	
DISCHARGE RATE	AMPS	RECHARGE RATE	AMPS

BELOW THIS LINE TO BE COMPLETED BY ENGINEERING						
DISCHARGE VOLTS				RECHARGE TIME	_____ HRS CONSTANT CURR	
TIME	MINUTES				_____ HRS CONSTANT VOLT	
HOURS	0	15	30	45	CALCULATIONS	
0					DISCH TIME TO 1.70V X TEMP CORR FACTOR X 100	
1					% A H CAP = _____	
2					= _____ %	
3					PREDICTED LIFE _____ YEARS	
4					PRESENT AGE _____ YEARS	
5					REMAINING LIFE _____ YEARS	
6						
7						

REMARKS: (NOTE ANY ABNORMAL CONDITIONS OF THE CELL BEFORE, DURING OR AFTER THE TEST)

Figure 3. Single Cell Discharge Test Record, Form S 4209.

Table 1. Temperature Correction Factors.

TEMPERATURE (°F.)	CORRECTION FACTOR
65	1.08
66	1.07
67	1.07
68	1.06
69	1.05
70	1.05
71	1.04
72	1.03
73	1.03
74	1.02
75	1.01
76	1.01
77	1.00
78	0.99
79	0.99
80	0.98
81	0.97
82	0.97
83	0.96
84	0.95
85	0.95

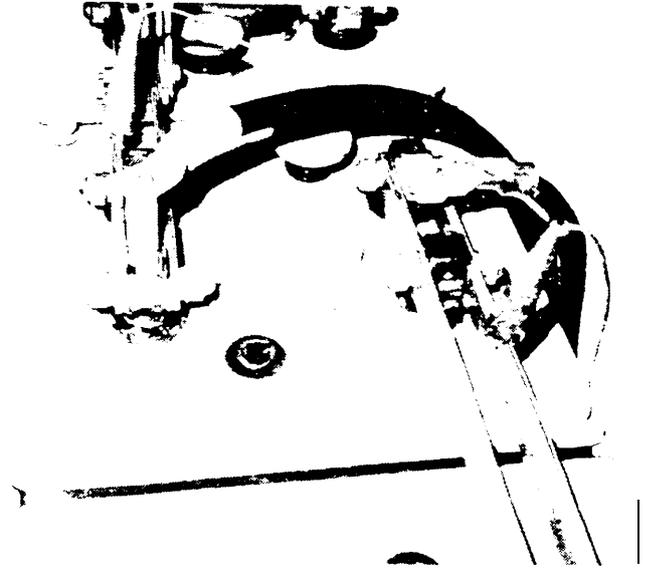


Figure 5. Power and Reference Leads Connected to Ceil.

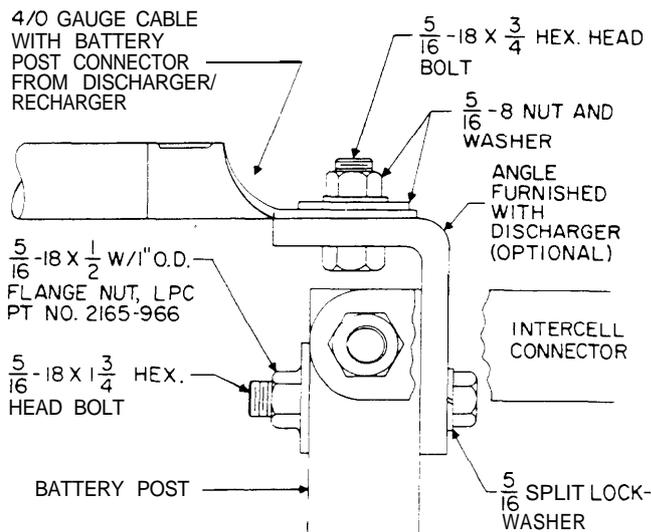


Figure 4. Typical Connection of Power Lead to Battery Post.

- (4) Tighten all connections of step 3, and check that the CORRECT POLARITY lamp on the discharger/recharger control panel lights (Figure 1). If the REVERSE POLARITY lamp lights instead, reverse the connections at the cell terminals.
- (5) Connect the red reference lead to the positive cell connecting strap as close as possible to the terminal post (Figure 5). Connect the black reference lead to the negative cell connecting strap in the same manner. Do not connect either reference lead to the terminal lug of the corresponding 4/0 gauge cable.

CAUTION: Damage to the discharger/recharger may result if the unit is operated with these leads connected with reverse polarity.

- (6) Connect the three-conductor ac input cord to the male receptacle adjacent to the output terminals (Figure 2). Plug the opposite end into a source of 117-volt, 60 Hz, single-phase ac power.

(7) Consult the nameplate of the cell under test to obtain its ampere-hour (AH) capacity. Using this figure, refer to Table 2 to determine the proper discharge rate. Enter the result in the DISCHARGE RATE space in the TEST EQUIPMENT AND ADJUSTMENT section of Form S 4209. Enter one-half this value in the RECHARGE RATE space of the same section.

On the discharger-recharger control panel adjust the controls as follows:

(a) Set the DISCH/CHG selector to the discharge rate determined in step 7.

Place the range selector control for the dual-range ammeter in the appropriate position. For example if the setting of the DISCH/CHG selector is 290/145 amperes, place the range selection the O-300 A position.

Place the ON/OFF switch in the ON position.

(d) Rotate the programmer control clockwise to the TEST position.

(e) Operate the NORMAL/TEST DISCHARGE switch to the TEST DISCHARGE position. Hold it in that position and adjust the FINE CURRENT ADJUST knob until the required discharge current is indicated on the ammeter. Then restore the NORMAL/TEST DISCHARGE switch to the NORMAL position.

(f) Advance the programmer control clockwise to the BOOST position.

3.03 The remaining operation of the discharger/recharger is fully automatic as follows:

(a) The programmer remains in the BOOST position, until the cell voltage is raised to the regulated charge voltage of 2.55 volts, and has been charged at that voltage for 2 additional hours.

Table 2. Discharge Rate Per AH (8-hour) Capacity of Cell.

CELL RATING (AMPERE HOURS AT 8-HOUR RATE OF DISCHARGE)	DISCHARGE RATE AMPERES AT 5-HOUR RATE OF DISCHARGE	CHARGE RATE (AMPERES)
160	31	15.5
240	43	21.5
300	52	26
420	74	37
540	93	46.5
660	120	60
840	145	72.5
1080	180	90
1320	230	115
1680	290	145
2128	290	145

NOTES: 1. Charge rate is one-half the discharge rate and is automatically selected with discharge rate.

2 To determine the percentage of reserve capacity, refer to Table 3 and Figure 6.

- (b) At the end of the time period of step a, the programmer advances to the DISCHARGE position, and a 2.5-volt calibration point is recorded by the recording voltmeter as shown in Figure 6.
 - (c) The programmer remains in the DISCHARGE position until the cell voltage reaches the low limit of 1.70 volts. At this point, the turnaround circuit in the discharger/recharger operates and advances the programmer to record a 1.8-volt calibration point on the tape (Figure 6).
 - (d) After recording the 1.8-volt calibration point, the programmer advances to the CHARGE position. The discharger/recharger then proceeds to recharge the cell at one-half the discharger rate, until the cell voltage again reaches 2.55 volts.
 - (e) When the cell voltage of 2.55 volts is reached, the 2-hour timer automatically resets, and the 2.55-volt charge is continued. At the end of the first 2 hours, the timer resets, and the 2.55-volt charge is continued for another 2-hour period. This process is repeated until four of these 2-hour periods (8 hours total) of 2.55-volt charging are completed.
 - (f) At the end of the charging period of step e, the programmer advances to the OFF position, and disconnects the cell from further testing. The cell, however, is still on float charge with the remainder of the battery.
- 3.04 When the discharger/recharger has cycled through the sequence of Paragraph 3.03, perform the following:
- (1) Restore the ON/OFF switch to the OFF position.

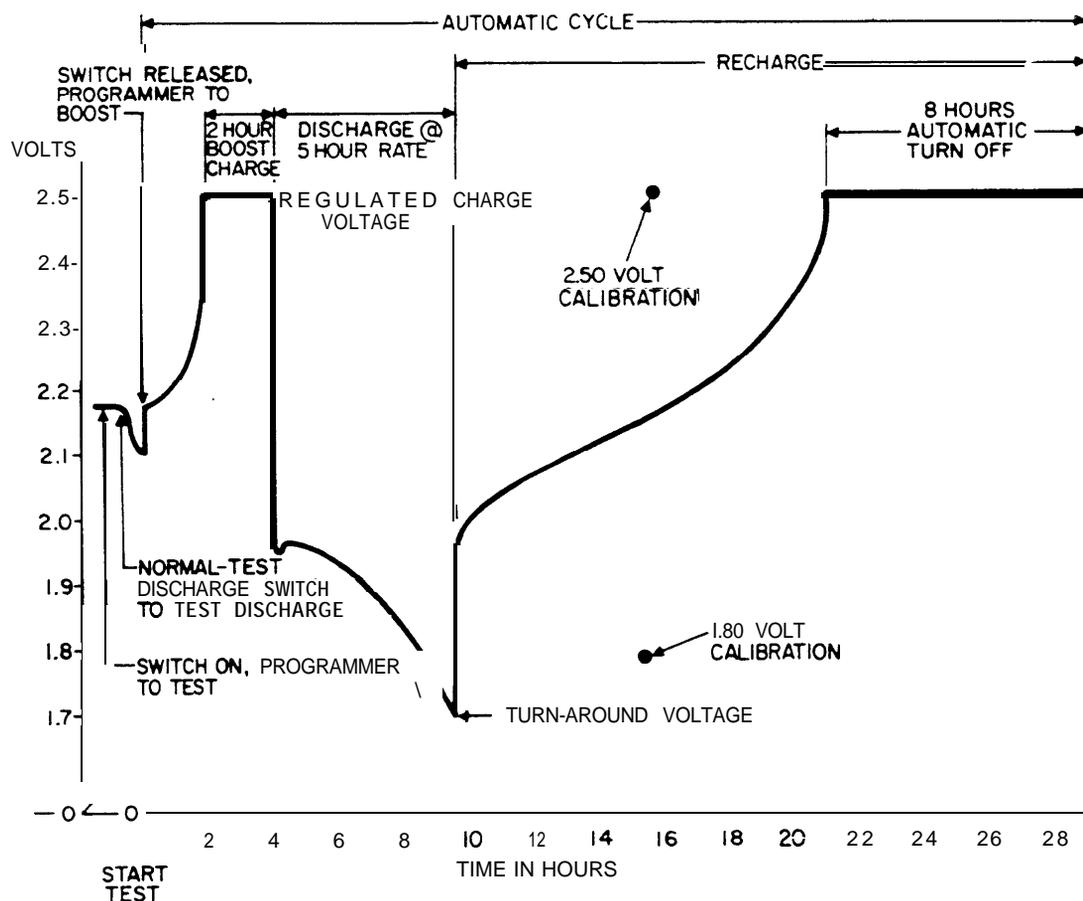


Figure 6. Typical Recording Tape Results for Lead-Calcium Cells.

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- (2) Disconnect the ac input cord from the source of power.
- (3) Disconnect the reference leads from the connecting straps.
- (4) Disconnect the power leads from the battery terminals.
- (5) Disconnect all leads from the discharger/recharger, and store both the leads and the unit in their proper places.
- (6) Using the hydrometer, measure the specific gravity of the cell. Enter the results in the SPECIFIC GRAVITY space in the AFTER TEST CONDITIONS section of Form S 4209.
- (7) Using the 931 voltmeter, measure the voltage of the cell tested. Enter the results in the CELL VOLTAGE space in the AFTER TEST CONDITIONS section of Form S 4209.
- (8) Using the battery vent thermometer, measure the cell temperature. Enter the result in the CELL TEMPERATURE space in the AFTER TEST CONDITIONS section of Form S 4209.

Lead-Antimony Cells

3.05 Prior to using the model AP300A2 Portable Discharger/Recharger for testing lead-antimony battery cells, adjust the voltage level of the discharger/recharger, in accordance with the procedure in Section 108-850-100, to 2.35 volts.

3.06 When testing a lead-antimony cell, make certain that the cell is fully charged by applying a check charge, or equalizing charge, if necessary, as instructed in Section 205-010-301. To prevent effects of the charge from influencing test results, a test discharge should not be performed less than 2 weeks after equalizing. It will also be necessary to eliminate the boost portion of the automatic cycle.

3.07 To test a lead-antimony cell for reserve capacity:

- (1) Make certain that the discharger/recharger is adjusted in accordance with Paragraph 3.05.
- (2) Perform steps 1 through 6 and steps 8a through 8e of Paragraph 3.02.
- (3) Advance the programmer to the BOOST position, wait 1 minute, and then manually advance the programmer to the DISCHARGE position.

3.08 At the completion of Paragraph 3.07, step 3, the discharger/recharger operation becomes fully automatic as follows:

- (a) At the completion of Paragraph 3.07, step 3, a 2.5-volt calibration point is recorded by the recording voltmeter as shown in Figure 6.
- (b) The programmer remains in the DISCHARGE position until the cell voltage reaches the low limit of 1.70 volts.
- (c) When the cell voltage reaches 1.70 volts, the turnaround circuit in the discharger/recharger operates and advances the programmer to record a 1.8-volt calibration point on the tape as shown in Figure 6. The programmer then advances to the CHARGE position.
- (d) In the CHARGE position, the discharger/recharger recharges the cell at one-half the discharge rate, until the cell voltage again reaches 2.35 volts.
- (e) When the cell voltage reaches 2.35 volts, the 2-hour timer automatically resets, and the 2.35-volt charge is continued. At the end of the first 2-hour period, the timer resets and the 2.35-volt charge is continued for another 2 hours. This process is repeated until four of these 2-hour periods (8 hours total) of 2.35-volt charging are completed.
- (f) At the end of the charging time of step e, the programmer advances to the OFF position, and disconnects the

cell from further testing. However, the cell is still on float charge with the remainder of the battery.

3.09 When the discharger/recharger has cycled through the sequence of Paragraph 3.08, perform the operations of Paragraph 3.04 to complete the testing operation.

4. ANALYSIS OF TEST RESULTS

4.01 The percentage of reserve capacity is calculated as shown in Tables 3 and 4.

4.02 The decision as to when to replace a battery depends upon a number of factors, including:

- (a) Hours of reserve, required and existing
- (b) Rate of growth of the load
- (c) Importance of the service
- (d) Condition of the battery as determined from all available records
- (e) Low-voltage limits of the equipment. Voltage may be below requirements when the battery is at 70 to 75 percent of reserve capacity.

4.03 Characteristics of a cell voltage record may reveal certain information about the cell. The following may serve as a guide, but judgement and experience are essential to meaningful conclusions:

- (a) Low voltage (1.90 volts or less) may indicate that the cell was not fully

charged, or that it has abnormally high resistance. The high resistance may be due to a poor electrical connection between posts and plates, advanced corrosion of grids, or other causes.

- (b) Abrupt changes in voltage during discharge indicate a loose internal connection.
- (c) If the constant charging period is appreciably lower than twice the discharge period, high cell resistance is indicated.

5. CHARGING A SINGLE CELL

5.01 A cell sometimes requires separate charging to restore it to a normal condition. By eliminating both the BOOST and DISCHARGE cycles, this may be accomplished by use of the discharger/recharger as follows:

- (1) Make the connections as instructed in Paragraph 3.01 and Paragraph 3.02, steps 3 through 6.
- (2) Adjust the discharger/recharger controls as instructed in Paragraph 3.02, steps 7 and 8.
- (3) Advance the programmer to the BOOST position, wait 1 minute, then manually advance the programmer to the RECHARGE position. The remainder of the operation is as described in Paragraph 3.08, steps c through f.

Table 3. Reserve Capacity Calculation.

<p>Percentage Capacity = $\frac{\text{Discharge Time (Hours)} \times \text{Temperature Correction Factor}}{5} \times 100$</p> <p>Where:</p> <p>The automatic discharge time is measured directly from the test record of Figure 6, in which 1 inch equals 1 hour.</p> <p>The temperature correction factor is that which was entered in the TEMP. CORR. FACTOR space in the PRE-TEST CONDITIONS section of the Form S 4209 for the tests.</p> <p>*NOTE: The divisor of 5 is based on a discharge rate of one-fifth of the 5-hour capacity (Table 4). Use a divisor of 7.3 for 2128 AH cells.</p>

Table 4. 5-Hour AH Capacity of Standard Cells.

8-HOUR CAPACITY	5-HOUR CAPACITY
420	360
450	393
840	735
1680	1470