

CHARGING STORAGE BATTERIES

GENERAL

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2. GENERAL2.1 Scope

2.11 This section contains the general information required when preparing to charge and use enclosed type storage batteries.

2.12 The requirements shall have been met and installation complete as covered in the 17 series before the charge is started.

2.13 The operations and measurements of Sections 18B and 18F or 18C and 18F shall be applied to each new battery before it is turned over to the telephone company.

2.14 The initial charge procedure including requirements is now contained in each of Sections 18B and 18C so it is possible to complete the charge portion without referring to Sections 18D, 18E and 18F. Sections 18D, 18E and 18F do, however, contain supporting reference material and may in some cases be required. Section 18F is always required for administering the Boost Charge and maintaining the battery between the initial charge and turnover.

2.15 As indicated in the Table of Contents other sections in the 18 series contain information on charging, voltages, electrolyte and maintenance.

2.16 The charging of batteries used primarily for engine starting is covered in Section 19 of this handbook.

2.17 References in the 18 series of sections apply to new cells charged and shipped filled or charged and shipped dry.

2.18 The cells are fully charged when they leave the battery manufacturer for direct shipment. The "Initial Charge" will replace the energy lost on open circuit during shipment.

2.19 KS-5361, L151H is a high gravity cell and any charge that may be required is described in Handbook 227, Section 1105.

2.2 Cautions

2.21 Refer to Section 17A of this handbook for precautions to be observed during the application of the 18 series of sections. Additional precautions are as follows:

2.22 Exercise care so as not to cause a spark at the gas vent when taking hydrometer, temperature and voltmeter readings on cells with no antiexplosion feature or when installing new vents on any type of cells in service.

2.23 All electrolyte removing, filling, temperature reading and hydrometer reading should be done only through the filling funnel. Some cells are equipped with electrolyte withdrawal tubes through which the hydrometer is used. In either case the tip of the funnel and withdrawal tube are kept below the surface of the electrolyte to prevent a spark from reaching the area of trapped gas between the electrolyte and the cover. Exide cells excepted.

2.24 Do not connect taps to a battery. Do not subject a portion of the battery to a different charge or discharge condition that would not be common to the entire string. Tapping a battery may prevent the cells from meeting voltage or specific gravity requirements.

2.241 The only deviation from these requirements may be made when it is necessary to charge a new cell connected in the battery string, using a single cell charger.

2.25 Do not perform any installing operations on or around a battery while it is gassing appreciably.

3. TOOLS & SUPPLIES

3.1 Tools

<u>Code</u>	<u>Description</u>
ITE-4040	Adjusting Set - DC (See Note)
R-3055	Goggles, Safety (All Plastic)

NOTE: It is desirable to use the meter which the telephone company uses. If it is available, then the ITE-4040 set will not be required.

3.2 Supplies

<u>Code</u>	<u>Description</u>
KS-14666	Cloth, Cleaning
Obtain Locally	Calibrated Pitcher (Pyrex, Glass, Glazed or Earthenware)
Obtain Locally	Bicarbonate of Soda
ID-1285	Storage Battery Report

4. REQUIREMENTS

4.1 An initial charge should be completed and satisfactory voltage and gravity measurements obtained on each new battery before it is turned over to the telephone company.

4.11 When this is not possible, the battery may be presented for acceptance if there exists any of the conditions listed below. This acceptance procedure is in agreement with that authorized to the telephone companies in PEM 7101 which assures them that Western Electric retains full responsibility for the battery without resort to a Formal Engineering Complaint.

4.111 When the specified charge has been applied and certain cells have failed float voltage requirements or, specific gravity requirements on cells not having withdrawal tubes.

4.112 When charging equipment, by design, cannot be altered to charge above 2.20 volts per cell and the charge, per table in Section 18C, would extend beyond the installation interval.

*4.113 In a working office and in the absence of charging equipment being installed - when charging facilities cannot be released by the telephone company for battery charging purposes. In this case the cells are connected with the working battery necessitating a prolonged charge beyond the installation interval.

4.2 The charge voltage should be at the maximum available to the installer but not over 2.50.

5. DETERMINING PREFERRED CHARGING PROCEDURES

5.1 If the available charging equipment is capable of charging at 2.50 volts per cell and if the charging equipment and battery can be disassociated from the working office there is little difference between the arbitrary length method and the measured end method of charge as to the time required to charge the battery.

5.2 The Arbitrary Length Charge is desirable when the charge is made at a reduced voltage. Where the capability of the charging equipment does not permit charging upwards to 2.5 volts per cell or if the cells are connected to working equipment and permission cannot be obtained to raise the battery potential above 2.20 volts per cell then the arbitrary length charge should be used.

5.3 The Arbitrary Length Charge must be used when it is not practical to measure or accurately estimate the current going into the string, or when a battery is protected by interlocks (as in the 425A plant) so measurements while charging are impossible.

5.4 By using automatic voltage regulation with the arbitrary length charge, the charge can proceed for days, or weeks if necessary, with less attention from the installer and without supervision other than that provided by the alarm circuits.

5.5 Since this charge is arbitrary, it supplies to every cell (per the table) enough current to fully charge a battery in partially any condition of discharge. Few batteries (especially KS-15544 and KS-15886) require this much charge, so this may waste the installer's time as compared to the measured end charge which supplies only sufficient current to restore the battery to a fully charged condition.

5.6 The Measured End Charge is recommended where the cell voltage can be raised to 2.50 volts and the cells can be disassociated from working equipment. Conversely, it is not recommended with charge voltages below 2.5 volts per cell because it requires hourly supervision to detect the start of stability and charges below 2.5 volts are likely to run for many hours. The charge to stability is followed by a brief added charge (per the table) which assures that minor plate areas, too small to detect by measurement, are fully charged.

5.7 Cells Shipped Dry must receive an initial charge at a high rate in accordance with Section 18B if they are to achieve normal life expectancy. Few of the small power plants, especially PBX supplies, will provide this much current because the voltage cannot be raised high enough.

5.8 Lead-calcium cells, KS-15544 and KS-15886 when shipped dry are not standard in the Bell System and not guaranteed to meet voltage variation requirements by the manufacturer or by the installer.

5.9 When the installer is required to charge such cells under either of the foregoing conditions he should notify the telephone company of these limitations and that provisions of PEM 7101 which extend installers responsibility for cells accepted in doubtful condition do not apply to these cells.

6. INITIAL CHARGE

6.1 Regular

6.11 The initial charge shall be the charge described in Section 18B or 18C. This shall be followed by Section 18F.

6.12 Cells shipped filled with electrolyte should be given the initial charge within 3 months for lead-antimony cells and 6 months for lead-calcium cells as determined from the shipping date as shown on the manufacturer's packing slip. If this is not available measure from the first day of the month and year as indicated on top of the cell. See date codes in Section 17A under "Battery Report ID-1285".

6.13 For cells shipped filled, if initial charge cannot be given within 3 months after shipment for lead-antimony cells or within 6 months after shipment for lead-calcium cells, there are two alternatives.

6.131 The interval of time during which a regular initial charge can be given may be extended indefinitely by applying one of the following charges and starting the charge before the expiration of the 3 or 6 month interval.

(a) Floating the battery at 2.15 to 2.19 volts per cell, 24 hours a day.

(b) Charging at 2.20 to 2.30 volts per cell, 7 or 8 hours a day and five days a week.

(c) Giving a boost charge every 6 to 8 weeks.

6.132 The 3 or 6 month interval may be allowed to lapse but not to exceed 6 months for lead antimony cells or 12 months for lead-calcium cells. The penalty to the installer is only a somewhat prolonged initial charge. There is, however, a question as to whether or not some cells may suffer a loss in life. This alternative shall therefore be used only with the approval of the telephone company.

NOTE: Every effort should be made to start the regular charge before the expiration of the 3 or 6 month period from the date the cells were shipped.

6.14 If the (3 month lead-antimony - 6 month lead-calcium) period is extended, record the method employed and the dates started and stopped under remarks on ID-1285.

6.2 Delayed

6.21 Shipment to Charge Period From 3 to 6 Months for Lead-Antimony and from 6 to 12 Months for Lead-Calcium Cells

6.211 If the (3 month lead-antimony - 6 month lead-calcium) period was not extended, and the interval between the date of shipment and the start of the

charge has been from 3 to 6 months for lead-antimony or 6 to 12 months for lead-calcium cells the telephone company shall be notified and the initial charge shall be given under the conditions for a Delayed Initial Charge as defined in Section 18C.

6.22 Shipment to Charge Period in Excess of 6 Months for Lead-Antimony and 12 Months for Lead-Calcium Cells

6.221 When cells were not charged or floated as covered in Paragraphs 6.12 and 6.13 and the 6 month or 12 month period has expired (Paragraph 6.211 when a Delayed Initial Charge should have been administered), arrangements should be made with the battery manufacturer's representative through supervisory channels for instruction on disposition or special method of charge as directed.

6.222 This handbook does not cover a recommended method of charge for cells in this condition.

6.3 Cells Shipped Dry

6.31 Cells shipped dry must be charged within one year after shipment. The charge shall be started after 10 but before 15 hours from the time the electrolyte is added.

6.32 Cells shipped dry must be charged by the measured end method in accordance with specific rates as described in Section 18B.

7. REUSED CELLS

7.1 If desired by the telephone company, reused cells and batteries shall be given a charge as directed by them.

8. CELLS ADDED TO A STRING

8.1 When a new cell is added to a charged string, a single cell charger may be used for the initial charge. Where a single cell charger, (J86264A), is not available or for other reasons this is impracticable, it will be necessary to give the charge to the entire string using the added cell as the pilot cell and basing length of charge on the voltage of the pilot cell according to the charge table and not the average cell voltage of the string.

8.2 When a new cell has been connected in a battery that is being floated and the new cell will receive its initial charge by connecting a single cell charger to the cell, the potential of that cell will drop to approximately 2.08 volts shortly after the charger is removed. If the cell has been given the proper charge and is in good condition, its potential will increase slightly after a few days. At the end of two or three months it should meet voltage requirements.

9. EMERGENCY CELLS

9.1 In new offices and with power plants such as the 302-A the emergency cells can be charged in series with the regular battery. When adding emergency cells in a

working office they should be charged separately. See Figure 1. In some offices power plants such as the 303-A and 708-A are permanently arranged to separately charge the emergency cells.

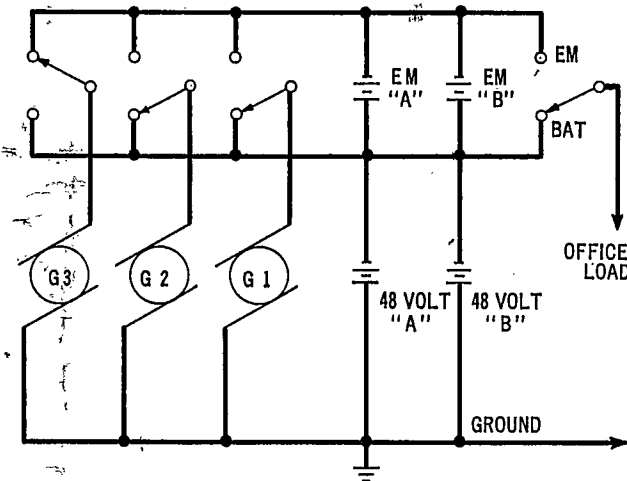


FIG. 1 TYPICAL ARRANGEMENT FOR CHARGING EMERGENCY CELLS SEPARATELY IN A WORKING OFFICE (PAR. 9)

9.2 Explanation of Figure 1. With the office operating normal under automatic voltage regulation, assume G3 as the added charging equipment or the existing one selected for the charge. Also assume Emergency string "B" as the one under consideration for charge. The Battery bus supplying the office load would be maintained at a potential of 49.9 volts or, 2.17 volts per cell on the regular string. By switching G3 to the Emergency position, the Emergency Cell voltage can be raised to 2.50 volts per cell or at an Emergency bus potential of 59.9 volts. The amount of current shown on G3 would divide evenly between each string of Emergency Cells provided each string is of the same age and same Ampere Hour Capacity. If the cells are of a different age refer to Paragraph 11.3 for obtaining a more accurate reading. Existing Emergency string "A" would be receiving an overcharge. The total current through the Emergency Cells would be distributed between floating the regular battery and the office load. The regular office charging equipment would function to automatically reduce its charge by this same amount of current.

10. SELECTING THE PILOT CELL

10.1 The pilot cell selected for the purpose of the initial charge is a temporary pilot cell. It shall be the cell with the lowest specific gravity or any cell too low to read on the standard hydrometer. Cells shipped dry need not be measured individually for lowest gravity as all cells read the same when filled with the same electrolyte. In this case select a cell convenient to read.

10.11 Never select a cell to be used as a pilot cell when it is at the end of a row of cells, next to a radiator or window, or over a working counter-cell.

10.2 When more than one string is charged in parallel it will be necessary to select a separate temporary pilot cell for each string.

10.3 The telephone company may choose to continue using as a permanent pilot cell, the one selected for the purpose of the initial charge. They may, however, need added pilot cells as they need one pilot cell per string where the installer uses only one pilot cell for two or more strings charged in series (48 Volt Battery and EM Cells Group "A" & Group "B").

10.31 A permanent pilot cell should reliably represent an average condition as a measure of over-all string operation. It should not be over counter cells or in any location affected by temperature changes not common to the string in general.

10.4 The 70-cell tapped battery used in carrier auxiliary stations requires only one pilot cell during the initial charge. After the charge, the telephone company will select pilot cells for the separate groups as required.

10.5 When charging 250 volt batteries the over-all string voltage divided by the number of cells will suffice as the "pilot-cell" voltage since it is not possible to measure cell voltage when the battery is under charge.

11. PARALLELING STRINGS

11.1 General

11.11 Charge strings of new cells separately from working strings when possible, paralleling as many new strings as the charging facilities will accommodate. This may not be possible when the use of temporary charging equipment cannot be made available or when existing charging equipment cannot be disassociated from the working office. Charging new cells in parallel with fully floated working cells necessitates an extended period of charge at a reduced voltage.

11.12 When charging parallel strings of new cells with the same capacity, the current in each string can be reliably estimated as dividing evenly.

11.2 Making Connections to Working Strings

11.21 When connecting a charged or uncharged string to a working string the working string should be somewhere near the floating voltage range; i.e., not under appreciable charge.

TABLE A

FINISHING RATES, AMPERE HOUR CAPACITIES AND IDENTITY AS TO LEAD-CALCIUM OR LEAD-ANTIMONY

Cell KS Number	Cell List No.	Finishing Rate in Amps	Ampere Hour Capacity
KS-5361 Lead-Antimony	100	.5	4
	110	1	10
	111	1	10
	116	1	10
	116B	1	10
	116C	1	10
	120B	1.5	15
	120C	1.5	15
	130B	3	30
	130C	3	30
	140A	5.25	50
	141A	5.25	50
KS-15886 Lead-Calcium	150A	10.5	100
	151A	10.5	100
	151H*	10.5	130
	140	5.25	50
	141	5.25	50
	150	10.5	100
KS-5553 Lead-Antimony And KS-15544 Lead-Calcium	151	10.5	100
	310	18	180
	311	18	180
	402	24	240
	403	30	300
	405	42	420
	407	54	540
	409	66	660
	501	70	840
	503	90	1080
	505	110	1320
	508	140	1680
KS-5562 Lead-Antimony	04	210	4000
	05	250	5000
	06	290	6000
	07	350	7000

*List 151H is a high gravity cell. PAR. 2.19

11.22 The connection which completes the paralleling shall be made some distance away from the batteries to reduce the hazard of a spark. Usually this tie may be made at the charging equipment. Allow the higher voltage string to discharge or charge the lower voltage string until a difference between strings is within .05 volt. Measure across the connection which will provide the paralleling. The purpose of adjusting to this small difference in voltage is to reduce the circulating currents thereby reducing the chance of a spark the instant the connection is made.

11.23 The permanent connection at the battery terminal can then be made since a parallel path has already been established.

11.3 Determining Charge Current - Paralleling with a Working String

11.31 When new cells must be charged in parallel with an existing and working battery, the following method may be used to determine the current through the new string or strings.

11.311 Before connecting the new cells, elevate the voltage on the existing battery to the boost value for that particular office (usually 2.20 to 2.30 volts per cell) and allow five minutes to stabilize.

11.312 Deduct the current indicated on the discharge ammeter from the total current shown on the charging units. This difference is the current through the working cells.

11.313 Tie in the new cells as described in Paragraph 11.2.

11.314 After starting the charge and raising to the same boost voltage, again obtain the difference between the charge and discharge current. From this, subtract the value obtained in 11.312 (b). The difference is the approximate current at the constant voltage through the new cells and is satisfactory for use on the ID-1285 Storage Battery Report.

12. CHARGING 70-CELL TAPPED BATTERY

12.1 When replacing a 70-cell tapped battery, it is not always practical to replace the entire battery the same day. This results in high voltage on new groups and low voltage on old groups during installation. This condition is aggravated where the new groups are lead-calcium and the old lead-antimony. In such cases it is recommended that float current be reduced by lowering the over-all voltage during the few days required so that the voltage on new cells will not exceed 2.30 (2.20 maximum preferred), but if possible, not so low that the voltage of the old cells is less than 2.05 volts.

13. CHARGING FACILITIES

13.1 Determine whether there will be any office circuit voltage limitations during the charging period. If so, employ countercells or resistors as provided for maintaining normal voltage limits at the discharge bus. A thorough understanding of the charging setup for the particular plant as covered by the circuit description (CD) sheet for the charging circuit, is desirable.

13.2 The Bell Telephone Laboratories engineers in collaboration with the American Telephone and Telegraph Company have agreed to charging 24 hours per day and unattended at night, provided alarm circuits are in operation and permission is obtained from the local telephone company.

13.3 Operating instructions for the 302-A Power Plant as used for battery charging is contained in Handbook 21, Section 251-1.

13.4 When the regular charging equipment is not ready in time to make the initial charge an effort should be made to borrow charging equipment from the telephone company or to rent it from other sources.

14. PREPARING TO CHARGE - CELLS SHIPPED FILLED AND CELLS SHIPPED DRY

14.1 Before starting to charge determine that all connections are tight, that the assemblies are properly seated in the cell covers and it is evident that the correct electrolyte level indicators have been furnished, installed and that they operate freely.

14.2 Recheck each ceramic vent or explosion control device to determine that all are properly installed and securely seated.

14.3 Provide ample ventilation during charge to prevent an accumulation of gas from collecting around the cells.

14.4 Cells charged and shipped dry shall be filled to minimum level with electrolyte of $1.210 \pm .010$ specific gravity 10 to 15 hours before start of initial charge. Immediately before start of charge again bring all cells up to minimum level with electrolyte and check each cell with any available dc voltmeter to be sure all polarities correspond to post markings and circuit requirements. When cells are charged and shipped dry indicate this under remarks on ID-1285. Charge per Section 18B.

14.5 For cells shipped filled, add approved water as necessary to bring all cells up to "minimum level" and record additions on ID-1285 under "Electrolyte Level, Corrections."

14.6 Do not add water while electrolyte temperatures are below 50°F except as necessary to maintain level above plates. During charge the level may go above "maximum level" but should not overflow.

14.7 Do not remove electrolyte when above "maximum level" except as necessary to control overflow. If it should become necessary to remove electrolyte record removals on ID-1285 under the "Electrolyte Level, Correction" column. Retain electrolyte for possible reuse at the end of the charge period.

15. STORAGE BATTERY REPORT ID-1285

15.1 An ID-1285 Storage Battery Report shall be maintained on each battery throughout application of the 17 and 18 series of handbook sections and shall include all information required by these sections as specified.

15.2 Refer to the Job Clerical Handbook for information on mailing addresses and to whom copies should be sent. When all battery requirements have been met and the forms have been completed forward the battery supplier's copy promptly.

15.3 "Sheet number _____ of _____ Sheets" apply to those sheets covering one battery only. Use as many sheets as necessary for required information on the battery involved.

15.4 When two or more sheets are required to complete charging and maintenance information for a given battery or batteries complete heading information is required only on Sheet 1. On subsequent sheets fill in boxes titled "Job Order Number", "Sheet _____ of _____ Sheets" and "Battery Designation".

15.5 The column under the heading, "Electrolyte Level, Correction," will represent on the final form, a total of all additions (and removals if necessary) through the completion of the initial charge to turnover.

16. OUTLINE OF INSTALLING AND CHARGING PROCEDURES

NOTE: These are not requirements.

This is a summary of the more important requirements in the paragraphs indicated. For details, follow the sections and paragraphs indicated.

16.1 Install

- (a) Unpack and report condition. 17A 6.11, 5.2 - 5.5 17D 8
- (b) Inspect (cracked containers, spilled electrolyte). 17A 6.11 - 6.13
- (c) Cover plates. 17A 6.23 - 6.27
- (d) Replace shipping plugs. 17A 6.28
- (e) Place. 17C 7, 8, 9 17D 8
- (f) Connect. 17E 4, 5
- (g) Install accessories. 17F 4 - 7

16.2 Regular Charge

Lead-antimony cells up to 3 months old. Lead-calcium cells up to 6 months old. 18A 6.12

- (a) Select pilot cell (one pilot per parallel string). 18A 10
- (b) Charge by Measured End method to stability plus added charge per table. 18A 5.6 18B 6.2, 6.3
or
Charge by Arbitrary Length method until electrolyte is warmed plus added charge per table. 18A 5.2 - 5.5 18C 7.2, 7.3

Maximum 2.50 volts per cell. 18B 6.12 18C 6.1

- (c) At 3/4 charge per table, fill to maximum level. 18B 6.35 18C 7.7
- (d) While still under charge record voltage of each cell. Limits: average $\pm .10$ volt. 18B 10.1, 10.2 18C 8.2, 8.4
- (e) Reduce to 24 hour float voltage or, to 2.2 (or 2.3) volts 8 hours per working day. 18B 10 18C 9 18F 4.1, 4.2

- (f) Measure voltage, temperature and gravity of each cell while on float. Must be within 1 week of turnover; 3 days after initial charge and after 5 hours of uninterrupted float.

Limits: Voltage average $\pm .10$, $-.04$
 Gravity 1.195 to 1.225;
 Maximum difference .015.
 18B 12.12, 12.53 18C 11.12,
 11.53

- (g) Fill to maximum level. 18B 15.1
 18C 14.1

16.3 Delayed Charge

Lead-antimony cells open circuit from 3 to 6 months.

Lead-calcium cells open circuit from 6 to 12 months. 18A 5.21

- (a) Select pilot cell. 18A 10
 (b) Uncorrected pilot or average cell voltage 2.30 to 2.40. 18A 6.211
 18B 14.1 18C 13
 (c) Arbitrary Length - Charge until electrolyte is warmed plus 1-1/2 times hours in table. 18C 13.12
 (d) Follow Paragraph 16.2 (c), (d), (e) and (f).

16.4 250 Volt Battery

- (a) Select pilot cell. 18A 10
 (b) Charge by Arbitrary Length method until electrolyte is warmed plus added charge per table. Maximum charge 2.5 volts per cell average. Length of charge per table determined by pilot cell temperature (charge off momentarily) and cell average of string voltage. 18A 5.3
 18C 7.1
 (c) Individual cell charge voltage measurements waived. 18C 8.1
 (d) Measure voltage, temperature and gravity of each cell while on float.
 Limits: Voltage average $\pm .10$, $-.04$
 Gravity 1.195 to 1.225;
 Maximum difference .015
 18C 11.13, 11.12, 11.53

- (e) Fill to maximum level. 18C 14.1

- (f) For lead-antimony 3 to 6 months old or lead-calcium 6 to 12 months old follow Paragraphs 16.3 (a), (b), (c); 16.2 (c), (e); and 16.4 (c), (d) and (e) above.

16.5 Cells Shipped Dry

18A 5.7 - 5.9 18B 7.1

Charge within one year of factory shipment. 18A 6.3

- (a) Inspect. 17A 6
 (b) Fill to minimum level 10 to 15 hours before charge with 1.210 $\pm .010$ electrolyte. 18A 14.4
 (c) Verify polarities. 18A 14.4
 (d) Place and connect. 17C 7,8 17E - 4.1, 4.3, 5
 (e) Select pilot cell. 18A 9
 (f) Charge at 25% or 40% of cells eight hour rate until 100% of capacity has been applied.
 18B 7.2, 7.3
 (g) Fill to minimum level with water, then fill to maximum level with 1.210 $\pm .010$ electrolyte. 18B 7.4
 (h) Continue charge until voltage and gravity have ceased to rise.
 18B 7.4
 (i) Continue charge for 6 hours if at 25% rate or for 4 hours if at 40% rate. 18B 7.4
 (j) While still under charge record voltage of each cell.
 Limits: Average $\pm .10$ volt
 18B 7.6, 8.1, 8.2
 (k) Reduce to 24 hour float voltage or 2.2 (or 2.3) volts 8 hours per working day. 18B 10
 (l) Follow 16.2 (f).

→ Arrowed lines indicate new or changed information.

[Vertical line at side of paragraphs indicates requirements.

Reason for Reissue:

- (1) To recognize cells equipped with electrolyte withdrawal tubes as a means for measuring specific gravity.
- (2) To indicate that cells shipped dry should be charged between 10 & 15 hours after filling.
- (3) To prohibit charging cells shipped dry at a low voltage rate.
- (4) To make reference to Handbook 21 for instruction in use of the 302-A power plant for charging batteries.

R. W. HILLEGAS
 Engineer of Installation

Replaces Section 18A dated 6-16-60.