

# CHARGING STORAGE BATTERIES

## ARBITRARY LENGTH CHARGE

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2. GENERAL2.1 Scope

2.11 This section contains detailed information on the procedures to follow when using the Arbitrary Length method for the initial charge of an enclosed type storage battery shipped filled. Charge for cells shipped dry is covered in Section 18B. This section is to be used with the other sections in the 17 and 18 series.

2.12 It also contains the voltage and gravity requirements necessary for completing the charge and charge records which previously was covered separately in Sections 18D and 18E respectively.

3. TOOLS AND SUPPLIES

3.1 The required tools and supplies are listed in Section 18A.

4. PRELIMINARY OPERATIONS

4.1 Preparations of cells for charge are covered in the "Charging - General" Section of this handbook.

4.2 Continue the ID-1285 form originated in Section 17A by checking "Arbitrary Length" under type of charge. Indicate pilot cell number selected per Section 18A, number of strings charged in parallel, voltage regulation employed and whether or not battery is connected to working equipment while being charged. Record the complete date the charge is started.

5. TEMPERATURE OF ELECTROLYTE

5.1 The thermometer should be inserted in the cell funnel opening and held in the electrolyte for at least two minutes before taking any reading.

5.2 When there is insufficient clearance to insert the thermometer an acceptable alternate to reading each cell is to lay the thermometer on top of the cell in the center of a row and again on a cell at the end of a row. Allow 10 minutes before reading and use the average temperature as an approximation of the temperature of all cells in the row. Indicate temperature was approximated on ID-1285 in the space for remarks. This approximation may not be used for temperature correction of voltage when such a corrected voltage would condemn a cell.

5.3 The electrolyte temperature shall not exceed 110°F for more than 3 hours during any part of the charge. At no time shall the electrolyte temperature exceed 120°F.

5.4 If it is apparent that the next reading will exceed the limits stated above interrupt the charge and allow the electrolyte to cool to about 95°F. after which the charge may be resumed.

6. VOLTAGE - LIMITS AND CHARGE VALUES

6.1 The average or pilot cell voltage shall not exceed 2.50 during any part of the charge.

6.2 The charge voltage of a battery connected to working equipment should be at the "Boost Charge" voltage for that particular office. The charge voltage may be less than 2.20 but a minimum of 2.30 is preferred.

6.3 Although charging voltages upwards to 2.50 are recommended, some rectifiers such as J86281 are not arranged to elevate the battery voltage above 2.17 (52.1 volts for 24 cells) which necessitates a prolonged charging period.

6.4 When administering a Delayed Initial Charge voltage limitations are contained in the instruction.

7. ARBITRARY LENGTH CHARGE7.1 250 Volt Battery

7.11 The 250-volt battery as used with the 425A plant is equipped with interlocks on the doors. The battery will be disconnected from the charge and discharge circuit when the doors are opened. Use the over-all string voltage divided by the number of cells as the pilot cell voltage for record of the charge on ID-1285 and for use with Table "A". After a warmup period it will be necessary to open the doors, temporarily disconnecting the charge, to obtain pilot cell temperature readings.

7.2 Warmup Charge

7.21 The charge before application of Table A is intended as a warmup period which reduces the over-all length of charge. By examining Table A it will be seen that higher cell voltage and higher

2A 50/20  
163/20  
100/20

TABLE A

ARBITRARY LENGTH CHARGE (PARS. 6,7,13.12)

| VOLTS<br>PER<br>CELL                   | PILOT CELL ELECTROLYTE TEMPERATURE DEGREES F |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------|----------------------------------------------|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                        | 105                                          | 100 | 95  | 90  | 85  | 80  | 75   | 70   | 65   | 60   | 55   |
| TOTAL HOURS CHARGE OF ARBITRARY LENGTH |                                              |     |     |     |     |     |      |      |      |      |      |
| 2.50                                   | 16                                           | 20  | 25  | 30  | 37  | 45  | 55   | 65   | 76   | 96   | 115  |
| 2.49                                   | 18                                           | 23  | 27  | 33  | 40  | 50  | 60   | 70   | 84   | 107  | 128  |
| 2.48                                   | 20                                           | 25  | 30  | 36  | 45  | 53  | 65   | 75   | 93   | 117  | 139  |
| 2.47                                   | 23                                           | 27  | 33  | 40  | 50  | 60  | 70   | 85   | 105  | 130  | 156  |
| 2.46                                   | 24                                           | 28  | 35  | 44  | 52  | 65  | 75   | 95   | 115  | 140  | 168  |
| 2.45                                   | 26                                           | 32  | 40  | 47  | 60  | 70  | 85   | 100  | 125  | 160  | 192  |
| 2.44                                   | 28                                           | 35  | 42  | 52  | 65  | 78  | 95   | 115  | 140  | 175  | 210  |
| 2.43                                   | 32                                           | 38  | 45  | 60  | 70  | 90  | 110  | 130  | 150  | 190  | 228  |
| 2.42                                   | 35                                           | 42  | 52  | 65  | 80  | 95  | 115  | 140  | 170  | 215  | 258  |
| 2.41                                   | 38                                           | 47  | 58  | 70  | 90  | 110 | 130  | 150  | 185  | 235  | 282  |
| 2.40                                   | 43                                           | 52  | 65  | 80  | 100 | 120 | 140  | 170  | 205  | 260  | 312  |
| 2.39                                   | 48                                           | 58  | 70  | 90  | 110 | 130 | 160  | 190  | 225  | 290  | 348  |
| 2.38                                   | 50                                           | 63  | 75  | 100 | 120 | 140 | 170  | 200  | 250  | 315  | 378  |
| 2.37                                   | 55                                           | 68  | 82  | 105 | 130 | 160 | 190  | 230  | 275  | 350  | 420  |
| 2.36                                   | 60                                           | 75  | 90  | 118 | 140 | 170 | 200  | 250  | 300  | 385  | 462  |
| 2.35                                   | 68                                           | 81  | 100 | 130 | 160 | 190 | 230  | 280  | 340  | 430  | 516  |
| 2.34                                   | 75                                           | 90  | 115 | 140 | 175 | 200 | 250  | 300  | 375  | 470  | 564  |
| 2.33                                   | 85                                           | 100 | 130 | 160 | 190 | 220 | 280  | 325  | 410  | 520  | 624  |
| 2.32                                   | 92                                           | 115 | 140 | 170 | 210 | 250 | 300  | 370  | 450  | 550  | 660  |
| 2.31                                   | 100                                          | 130 | 150 | 190 | 240 | 280 | 330  | 400  | 500  | 630  | 756  |
| 2.30                                   | 110                                          | 140 | 170 | 210 | 250 | 300 | 360  | 450  | 550  | 690  | 828  |
| 2.29                                   | 125                                          | 150 | 190 | 235 | 280 | 340 | 400  | 500  | 610  | 770  | 924  |
| 2.28                                   | 135                                          | 170 | 200 | 250 | 300 | 360 | 450  | 520  | 670  | 850  | 1020 |
| 2.27                                   | 150                                          | 185 | 235 | 280 | 340 | 400 | 480  | 580  | 740  | 940  | 1128 |
| 2.26                                   | 170                                          | 200 | 250 | 300 | 375 | 450 | 520  | 650  | 820  | 1040 | 1248 |
| 2.25                                   | 190                                          | 220 | 280 | 340 | 425 | 500 | 600  | 750  | 900  | 1140 | 1368 |
| 2.24                                   | 200                                          | 250 | 300 | 375 | 450 | 550 | 660  | 800  | 1000 | 1250 | 1500 |
| 2.23                                   | 230                                          | 280 | 340 | 410 | 500 | 600 | 730  | 880  | 1100 | 1390 | 1668 |
| 2.22                                   | 250                                          | 300 | 375 | 450 | 580 | 680 | 800  | 1000 | 1230 | 1540 | 1848 |
| 2.21                                   | 280                                          | 340 | 400 | 500 | 650 | 750 | 900  | 1100 | 1350 | 1700 | 2040 |
| * 2.20                                 | 300                                          | 375 | 450 | 570 | 700 | 820 | 1000 | 1250 | 1500 | 1880 | 2256 |
| * 2.19                                 | 300                                          | 375 | 450 | 570 | 700 | 820 | 1000 | 1250 | 1500 | 1880 | 2256 |
| * 2.18                                 | 300                                          | 375 | 450 | 570 | 700 | 820 | 1000 | 1250 | 1500 | 1880 | 2256 |
| * 2.17                                 | 300                                          | 375 | 450 | 570 | 700 | 820 | 1000 | 1250 | 1500 | 1880 | 2256 |

\*These voltages shall only be used when charging equipment cannot be altered to charge higher.

cell temperature will shorten the length of charge. When charging at a low rate this type of charge should be omitted.

7.22 Observe cells closely so as to prevent electrolyte overflow and so as not to exceed temperature limitations.

7.23 Start the charge and manually or automatically hold the voltage to the charge value to be used.

### 7.3 Charge per Table A

7.31 Start the charge per Table A. Apply to Table "A" the uncorrected pilot cell volts or average cell volts and pilot cell temperature to determine the number of hours to charge. Disregard the warmup period as credit towards the hours of charge indicated.

7.32 Hours of charge differ for each five degrees of temperature. Estimate to the nearest hour the charge to be made for intermediate degree readings.

7.33 Hours when the voltage falls below the value used in selecting hours per Table A, shall not be credited toward the total hours of charge shown.

7.34 Starting the charge per Table "A" marks the end of the actual charging procedure by the installer if limitations exist as described in Paragraphs 4.112 and 4.113 of Section 18A. The remainder of the charge period is observed as necessary by the telephone company maintenance force. The installer may return and take end of charge readings or he may arrange for the telephone company to furnish the readings for record on form ID-1285.

7.35 Continue with Paragraph 8 before shutting down charging equipment.

### 7.4 Interrupting Charge

7.41 If the charge is interrupted, the battery should be brought back to the same voltage as before the interruption and the periods at this voltage before and after the interruption should be added together. Disregard the temperature after the interruption unless there was a warmup period in which case, the temperature after the interruption must be at least as high as that used as a basis for time selection per Table A.

### 7.5 Charging Parallel Strings

7.51 When two or more strings requiring an initial charge are charged in parallel, measure the temperature and voltage of each pilot cell or the temperature of each pilot cell and average cell voltage. Apply this to Table A. The pilot cell indicating the greatest number of hours shall be responsible for the hours of charge for all of the parallel strings and shall govern the charge through any interruptions, etc.

7.52 For the strings depending on the pilot cell of another string for the number of hours of charge, a notation shall be made over "Remarks" on each of the corresponding ID-1285 forms. As an example on the form for 48V C:

"Length of charge determined by 48V B string," etc.

This will justify any apparent error between the number of hours required on 48V C and the actual number charged per 48V B if there should be any difference.

### 7.6 Record of Charge - ID-1285

7.61 Under "Pilot Cell Measurements, Initial Charge" record date, hour, current in amperes, uncorrected pilot cell volts or average cell volts and temperature of pilot cell at the following times:

7.611 At the start of the charge.

7.612 At the time the charge per Table A is started.

7.613 At the beginning and end of hours discounted when charge voltage is less than that applied to Table A.

## STORAGE BATTERY REPORT

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FIG. 1 EXAMPLE OF AN ARBITRARY LENGTH STORAGE BATTERY REPORT

7.614 When the charge is stopped due either to an interruption or end of charge.

7.615 When charge is resumed after an interruption.

7.62 On 250 volt battery only, record over "Remarks" that individual cell voltage readings under charge, are not required.

#### 7.7 Adjustment of Electrolyte Level

7.71 At the beginning of the last quarter of the charge per Table A when the gassing action can be utilized for mixing, add approved water as necessary to bring electrolyte in each cell up to "maximum level." If electrolyte was removed earlier to prevent overflow electrolyte shall be reused to bring the cell to "maximum level."

7.72 Record these additions of water on ID-1285 under "Electrolyte Level, Correction" column.

#### 8. END OF CHARGE READINGS AND REQUIREMENTS

8.1 250 volt battery cabinets are provided with door interlocks which disconnects the charger as the door is opened. Individual cell voltage readings on charge are not possible and therefore these readings and requirements are waived. Note this omission of readings on ID-1285.

8.2 Just before the charge is stopped take individual cell voltage and temperature readings. Do not reduce or change charging voltage until all readings are taken. Record these readings and the date on ID-1285 under "Individual Cell Measurements, Initial Charge." See Figure 1.

8.3 It is suggested the installer borrow the (Weston Model 931 0-3 Volt) meter from the telephone company to insure comparable readings. Otherwise the ITE-4040 can be used.

8.4 No cell voltage, corrected for temperature, shall be more than .10 volt above or below the average for the string.

8.5 For method of correcting voltage for temperature, refer to Section 18D.

8.6 If a cell or cells are out of voltage limits at end of the initial charge, give a second initial charge. This charge may be discontinued if at any time the voltages are found to be within limits.

8.7 Cells out of limits after two full initial charges are unsatisfactory and should be replaced through normal channels. See Paragraph 12.

#### 9. MAINTENANCE TO TURNOVER

9.1 As soon as possible after the initial charge, when the plant is under continuous attention either directly or by means of tested and attended alarm circuits, place the battery on continuous float.

9.2 Refer to Section 18F for detailed instructions and requirements.

#### 10. BOOST CHARGE

10.1 If time from the end of the initial charge to turnover exceeds six weeks, give the battery a boost charge during the final week.

10.2 Refer to Section 18F for the method of applying the Boost Charge and for the associated records to be kept.

#### 11. TURNOVER TO TELEPHONE COMPANY

##### 11.1 Float Voltage Readings and Requirements

11.11 Within a week of turnover, but at least three working days after the initial charge, record individual cell corrected voltages on float after at least 5 hours of continuous float. The final acceptable set of readings shall be recorded on ID-1285 under "Float at Turn-over."

11.12 No cell corrected voltage shall be more than .10 volt above or more than .04 volt below the average for the string.

11.121 For determining average cell voltage see Section 18D.

11.13 For 250-volt battery such as used in the 425-A Plant gaining access to the batteries by opening the cabinet doors disconnects the battery from the charge and discharge circuit. A rectifier, KS-15907 should be requested from the telephone company to maintain float voltage across the string while taking individual cell voltage readings. When the rectifier is not available the float voltage requirements are waived and notation to this effect should be made on ID-1285 under "Remarks."

##### 11.2 Rejected Cells - Below .06 Volts

11.21 Cells more than .10 volts above or more than .06 volts below the average for the string are unsatisfactory and should be replaced through normal channels. See Paragraph 12.

##### 11.3 Accepted Cells - .05 & .06 Volts Below Average

11.31 Cells .05 or .06 volts below the average for the string almost always meet requirements within a few weeks of continuous float operation.

11.32 Discuss this condition with the telephone company who may accept the battery on the recommendation of A.T. & T. Company's PEM 7101. When the telephone company accepts the battery per PEM 7101 this obligates Western Electric to replace free of charge and free of a Formal Engineering Complaint on the part of the telephone company, any cell not meeting the .04 volt below the average requirement after 10 weeks of continuous float operation.

11.321 To replace any unsatisfactory cells, accepted but still not of limits after 10 weeks of continuous float operation, the telephone company should issue a nonbillable, furnish and install requisition on the W.E. Co. Distributing House, worded as follows:

Furnish and Install No Charge:  
(Quantity) Battery, Storage, (Exide, C & D or Gould), KS-List, to replace defective cell furnished on Order No. and to be returned on RMN per P.E.M. 7101 and Engineering Complaint No. EC-129800.

Cross reference all papers connected with the replacement. See Paragraph 12.

11.33 At any time during or at the end of the 10 week period an endeavor should be made to obtain an acceptable set of readings for all cells.

11.331 An installer should take the readings if he is on the job or if it is reasonably convenient to return to the job. Otherwise, the telephone company may agree to take the readings and report them to the installer for record on ID-1285.

11.332 If taking readings at the end of ten weeks is expected to cause enough inconvenience to justify doing so, the cells may be replaced immediately. The Western Electric Company is then liable for transportation charges to and from the factory, for the difference between the cost of the new cell and the salvage allowed for those replaced and, the cost of removing and replacing the cell.

#### 11.4 Rejected Cells - .05 & .06 Volts Below Average

11.41 Cells .05 and .06 volts below the average for the string not accepted by the telephone company should be discussed through supervisory channels. The job may be held open up to 10 weeks while waiting for the cells to stabilize or the cells may be replaced without waiting to determine whether or not they are defective. The charges for which Western Electric is then liable is described in Paragraph 11.332.

#### 11.5 Gravity Readings and Requirements

11.51 Take the specific gravity and temperature readings of each cell within a week before turnover. Delay additions of water until after taking readings.

11.52 The acceptable set of readings shall be recorded on ID-1285 under "Individual Cell Measurements" - "Float at Turnover". If there is a boost charge required these readings may be taken before, during or after the charge.

11.53 The specific gravity requirements for fully charged cells corrected to 77°F per Table "B" and at the specified level are as follows:

11.531 Cells at 15 ampere-hour capacity and larger shall be from 1.195 to 1.225 inclusive.

11.532 On cells with charge indicators the gravity shall be sufficient to float all indicator balls.

11.533 The maximum specific gravity variation between fully charged cells of the same string shall not be greater than 15 points (.015).

TABLE B  
TEMPERATURE CORRECTIONS FOR HYDROMETER  
READINGS (PAR. 11.53)

| CORRECTION<br>VALUES<br>TO BE APPLIED<br>TO HYDROMETER<br>READINGS |          | Degrees F. With<br>REFERENCE<br>TEMPERATURE<br>AT 77°F |     |     |
|--------------------------------------------------------------------|----------|--------------------------------------------------------|-----|-----|
| ADD                                                                | SUBTRACT |                                                        |     |     |
|                                                                    | .007     | 55                                                     | 56  | 57  |
|                                                                    | .006     | 58                                                     | 59  | 60  |
|                                                                    | .005     | 61                                                     | 62  | 63  |
|                                                                    | .004     | 64                                                     | 65  | 66  |
|                                                                    | .003     | 67                                                     | 68  | 69  |
|                                                                    | .002     | 70                                                     | 71  | 72  |
|                                                                    | .001     | 73                                                     | 74  | 75  |
| 0                                                                  | 0        | 76                                                     | 77  | 78  |
| .001                                                               |          | 79                                                     | 80  | 81  |
| .002                                                               |          | 82                                                     | 83  | 84  |
| .003                                                               |          | 85                                                     | 86  | 87  |
| .004                                                               |          | 88                                                     | 89  | 90  |
| .005                                                               |          | 91                                                     | 92  | 93  |
| .006                                                               |          | 94                                                     | 95  | 96  |
| .007                                                               |          | 97                                                     | 98  | 99  |
| .008                                                               |          | 100                                                    | 101 | 102 |
| .009                                                               |          | 103                                                    | 104 | 105 |
| .010                                                               |          |                                                        |     |     |
| .011                                                               |          |                                                        |     |     |

11.54 If the cells are equipped with electrolyte withdrawal tubes true gravity readings will be indicated without a waiting period. Electrolyte readings taken from the top of the cells not equipped with withdrawal tubes may not reflect the true gravity for several months. After the initial charge, when it is impractical to get final acceptable gravity readings before turnover, discuss this with the telephone company to determine if they will furnish the readings for record on ID-1285 or if the installer will be required to return for final readings. If it should seem necessary to adjust electrolyte the installer shall discuss this by originating a Route "G" JIM on the "Supplies Inspection Organization." Provide information thoroughly identifying the cells and completely describing the applied charge and how the cells are defective.

11.55 Additional information on the use of the hydrometer and temperature correction is found in Section 18E.

#### 12. RETURNING CELLS

12.1 Add water as necessary to bring electrolyte to minimum level before returning cells.

12.2 Note complete information on the accompanying ID-177 tag in accordance with the Job Clerical Handbook and include a history as to length of charges, rates and total amount of water added.

12.3 Cells failing to meet minimum and maximum gravity requirements or charge voltage requirements should be further identified as defective and the reason stated.

12.4 Cells returned without waiting for float voltage stability within a given string or spread gravity stability within a given string should be identified as unacceptable and the reason stated.

12.5 Return cells promptly after replacements are made.

### 13. DELAYED INITIAL CHARGE

NOTE: This paragraph shall be applied only when specified by Section 18A.

13.1 The regular initial charge shall be given except that:

13.11 Voltage shall be between 2.30 and 2.40 volts per cell.

→ Arrowed lines indicate new or changed information.

[Vertical line at side of paragraphs indicates requirements.

13.12 The total hours of a charge of arbitrary length shall be one and one-half times the number of hours shown in Table A.

13.2 On ID-1285 over "Remarks", note that the Initial Charge was delayed and give the reason.

### 14. CLEANING AND FILLING

14.1 As a final measure before turning the battery over to the operating company and with the battery on float, fill all cells with approved water to the "maximum level". Record additions on ID-1285. Only when on float, clean the cells to remove dust and other foreign matter with a dry cleaning cloth KS-14666 or equivalent.

### 15. DISPOSITION OF ID-1285

15.1 Completed and approved ID-1285 forms shall be distributed in accordance with Job Clerical Handbook instruction.

R. W. HILLEGAS

Engineer of Installation

#### Reason for Reissue:

- (1) To provide alternate method of measuring temperature when thermometer cannot be placed in cell.
- (2) To restrict charge at 2.17 when charging equipment cannot be altered to charge higher.
- (3) To include voltage and gravity requirements previously shown in Sections 18D and 18E respectively.
- (4) To allow replacement of cells failing charge voltage requirements after two initial charges.
- (5) To require cells be placed on continuous float as soon as possible after the initial charge.
- (6) Float voltage requirements apply to 250-volt battery when separate float rectifier is provided.
- (7) To allow replacement of cells failing float voltage requirements by an amount lower than .06 volt.
- (8) To clarify the intent of PEM 7101 and more strongly recommend the telephone company accept marginal cells.
- (9) To repeat for emphasis the instruction to indicate the defect on returned cells.
- (10) To allow supervision to determine action on cells not turned over which have failed float voltage requirements by no more than .02 volts.
- (11) To recognize cells may be equipped with electrolyte withdrawal tubes which aid in determining the true gravity reading.
- (12) Cells failing gravity requirements discussed by originating a Route "G" JIM.
- (13) To guide in the disposition of completed ID-1285 forms.
- (14) To require initial charge be repeated when cells fail end of charge (under charge) voltage requirements.
- (15) To direct cleaning of cells and filling before turnover.

Replaces Section 18C dated 6-16-60.