

INSTALLATION OF COUNTERCELLS AND  
ENCLOSED-TYPE, LEAD-ACID BATTERIES

1. GENERAL

1.01 This section covers the installation of counter-cells as well as the installation and initial charge of enclosed-type, lead-acid storage batteries.

1.02 This section is reissued to number the section in both A and AA series. Section A301.009, Issue 7 on Initial Charge was canceled at the time this information was included in Section AA618.421, Issue 10-D on Installation. Field dissatisfaction with this cancellation of the A section indicated the need for a reissue with both numbers. The following changes from AA618.421, Issue 10-D are made in this dual-numbered issue.

- (a) Time per Tables A and B increased about 50 per cent and tables transposed to correct error.
- (b) Data added for cells shipped dry and charged.
- (c) Data added on KS-15754 high-gravity cells used in pole-mounted P carrier units.
- (d) Cell spacing information corrected.
- (e) Not only constant voltage and current but also constant specific gravity is specified as proof of stability on charges to a measured end.
- (f) Acceptance of cells with excess plate exposure disapproved.

1.03 Information in this section is arranged under the following headings:

- 1. GENERAL
- 2. PLATE EXPOSURE (Cells Shipped Filled)
- 3. HANDLING CELLS
- 4. LOCATING
- 5. PREPARATION OF CELLS
- 6. INITIAL CHARGE - GENERAL
- 7. ELECTROLYTE LEVEL (Low-gravity Cells Shipped Filled)
- 8. TYPES OF INITIAL CHARGE (Low-gravity Cells Shipped Filled)

9. FROM INITIAL CHARGE TO TURNOVER (Low-gravity Cells)

10. RECORDS (Low-gravity Cells)

11. LOW-GRAVITY CELLS SHIPPED DRY

12. HIGH-GRAVITY CELLS SHIPPED FILLED

1.04 Cells for telephone batteries are usually shipped charged and filled with electrolyte of low specific gravity (nominal 1.210), but KS-15754 cells for outdoor use are shipped charged and filled with electrolyte of high specific gravity (nominal 1.300). For some special jobs, the low specific gravity electrolyte is shipped separately and the cells are shipped charged and dry. The term dry is used herein to distinguish such charged and dry cells from the cells shipped filled.

1.05 The plates of KS-15544 and KS-15754 batteries have lead-calcium grids. All other batteries now being installed have plates with lead-antimony grids. Unless otherwise indicated herein, all of these instructions apply to cells with plates having either type of grids.

1.06 Cells as referred to herein are storage battery cells, unless counter-cells are mentioned.

1.07 When corrected (that is, corrected for temperature) voltage or specific gravity values are required, record also the uncorrected readings and temperatures on which the corrected values are based. To correct voltage readings, add 0.01 volt for each 3 degrees Fahrenheit any cell electrolyte is higher in temperature than the lowest temperature cell. Voltage readings need be corrected for temperature only if temperature variation between cells exceeds 2 degrees Fahrenheit. To correct specific gravity (hydrometer) readings, add one point (0.001) for each 3 degrees Fahrenheit which the actual temperature is above 77F and subtract one point for each 3 degrees Fahrenheit below 77F. Specific gravity correction values may be read directly from the thermometers usually furnished with the battery. (See 10.13.)

1.08 See Section A401.001 for finishing (nominal charging) rates, maximum and minimum levels, ampere-hour-rated capacities, and electrolyte specific gravity and voltage requirements. Also see

Section A401.001 for method of reading hydrometers, method of adjusting electrolyte, method of giving mixing charge, containers for handling electrolyte, approved water, precautions against explosions, spilled electrolyte, etc.

Caution: Avoid creation of sparks, including those from static electricity, or the use of an open flame near batteries, since the gas is explosive if sufficiently concentrated.

Caution: Part of a string should not be used to furnish load that is not furnished by the entire string. This means no tapping for test supplies and failure to observe this caution may cause battery to fail to pass voltage requirements.

<u>KS-5553 &amp; KS-15544 Lists</u>	<u>Elect. or Water Quarts</u>
310	1.25
311	1.25
402	1.50
403	1.75
405	2.00
407	2.50
409	3.00
501	2.75
503	3.00
505	3.50
508	4.00
<u>KS-5562 Lists</u>	

2. PLATE EXPOSURE (Cells Shipped Filled)

2.01 Cells with more than 1/2 inch of the top of the plates exposed for more than 20 minutes are unacceptable, as they may have concealed damage that cannot be corrected by field treatment. Cells with plate exposure should be discussed through normal channels. If possible, indications of spillage during shipment should be noted before acceptance of the cells from the carrier. Immediately after the cells are in the installer's hands, check the level (see 2.02), add electrolyte or water (see 2.03) as required (see 2.04), and note in the initial charge report the action taken.

2.02 With any type of cell, being able to pick up electrolyte with the hydrometer is proof that the plates are covered. With transparent containers, level can be seen. With nontransparent containers but where construction permits viewing the top of the plates, if electrolyte is not above top of plates, it must be assumed that more than 1/2 inch of the plates has been exposed. A portable electric light or flashlight may be used when observing level through a hole in the cover or walls of transparent containers. With some non-transparent containers, there is an anti-explosion chamber making it impossible for the top of the plates to be observed. On such cells, if electrolyte is so low in the container that it cannot be picked up with the hydrometer syringe and the condition has existed for more than 20 minutes, it will be necessary to measure the amount of electrolyte and/or water required to bring the electrolyte to minimum level. (See 2.03.) If more than the amounts given below is required, assume that more than 1/2 inch of the top of the plates has been exposed to the air.

04	16
05	21
06	26
07	37

2.03 Level below the top of the plates of cells shipped filled is assumed to be due primarily to spillage. In such cases, filling at this time to the minimum level with electrolyte of approximately nominal specific gravity (1.210 for low-gravity cells and 1.300 for high-gravity cells) may save considerable time later by making a specific gravity adjustment unnecessary. In some cases, small amounts of electrolyte can be moved with the hydrometer from a high cell to a low cell to get the plates all covered. In such cases, if plates are covered, raising level to the minimum may be deferred until later. If level is between minimum level and top of plates, it is assumed that the loss is due primarily to loss of gas and evaporation. In this case, water approved for battery use should be used to raise level from top of plates to minimum level. If level is below top of plates and electrolyte is not available, use approved water. If approved water is not available, use any clean water. At this point, getting top of plates covered is of first importance.

2.04 If plates are covered by electrolyte, it is not necessary for the good of the cells to raise level higher until called for near the end of the initial charge, but on cells with any type of antiexplosion feature, the antiexplosion feature is likely to be inoperative if electrolyte is below the minimum level. Electrolyte need not be removed from any cell to which no electrolyte or water was added by the installer, unless this is necessary to control overflow.

2.05 If it becomes necessary to return any filled cell to the manufacturer, add water before shipment, as necessary, to bring electrolyte level to minimum.

### 3. HANDLING CELLS

3.01 To speed up handling and reduce breakage, cells which are shipped on pallets should be left on the pallet until their final location is reached. However, they may be cut loose from the pallet and handled as individual cells whenever this becomes necessary or more convenient, as for example, where there is insufficient space or where lifting equipment is not of sufficient capacity to handle the entire assembly.

3.02 Lifting straps, when furnished, are marked with the KS number and list number of the cells for which they are designed. They are also marked with the battery manufacturer's name or trademark. Lifting straps shall be used only on cells for which they were designed. After installation of the battery, the lifting straps shall be discarded as the possibility of damage from acid makes it unsafe to reuse them. On larger Gould cells (KS-5562), the ceramic domes should be removed while using lifting straps. Use fingers to turn the domes, counterclockwise to loosen, clockwise to tighten. When replacing dome, moisten the rubber gasket with water and screw the bolt into the cover to a snug fit. It is seldom necessary to remove the dome on other Gould cells. The domes on Gould KS-15544, Lists 501 to 508 cells are as described above. The domes on smaller Gould cells have a screw base and no through bolts. They are removed, if necessary, by turning with the fingers counterclockwise to loosen, and clockwise to tighten.

3.03 Care shall be taken to avoid damage to battery or counter cell containers. This is especially important for glass and plastic containers since they are quite sensitive to scratches and other external damage. Extreme care shall be taken during uncrating and handling of such cells thereafter, using protective material to prevent any part of the jar from coming into contact with hard material; such as bare floors, steel racks, metal parts of lifting or moving devices, and tools. Once made, heavy scratches or other damage may grow to a point where the strength of the container wall is endangered. Note in the records, the position and length of any external scratches or internal crazing of the containers. Avoid exposure of plastic containers to petrolatum or solvents, such as kerosene, gasoline, petroleum spirits, cleaning compounds, and the thinner in waxes and polishes. Such materials tend to produce cracks or crazing in plastic.

3.04 The 5-gallon and larger containers of electrolyte or solution shall be left in their shipping cases. This is to reduce the chance for container breakage and limit the damage if there is breakage. The present trend is to smaller containers.

### 4. LOCATING

4.01 Cells should not be exposed to direct heat radiation. Sunlight may adversely affect the finish of rubber cell containers. Excessive heat from direct sunlight or nearby radiators may destroy the usefulness of charge indicators and will increase the local action in any type cell. It is especially objectionable for the local action of one or a few cells to be appreciably greater than for the remainder of the string. Such irregularities during shipping and installation period may seriously effect results from the initial charge and during life the effectiveness of the float and boost charges. Where batteries are being installed adjacent to radiators, or where direct sunlight will fall on them, the condition shall be called to the attention of the telephone company, who may wish to provide shields for the radiators and blinds for windows. Cells should be placed so that not more than 5 degrees Fahrenheit difference in electrolyte temperature will obtain between any cells in the same string. Temperature differences should also be avoided during shipment and storage.

4.02 When specified, install plastic or lead pans (previously called trays) under cells or under the entire battery. In general, this is done only in rented quarters or where spillage might result in unusual property damage.

4.03 Where flexible sheets of semihard rubber or plastic are specified, they shall be placed upon the shelves without shellac or other adhesive, being retained in position temporarily by a single cell or other weight while the cells are being placed and connected into position. If weights are not convenient, hold the ends of the strip by pieces of wood held in place by C clamps.

4.04 Large floor-mounted enclosed-type cells (KS-5562) may be tipped as much as 30 degrees momentarily in order to get through windows or past other obstructions, provided the shipping plugs are still in place. Other enclosed cells containing electrolyte shall not be tipped more than 15 degrees from vertical for more than a few minutes.

4.05 When cells are installed on the floor, the floor is to be leveled and finished in advance by the telephone company. Terminals

shall be in alignment within  $\pm 1/16$  inch for each cell and within  $\pm 1/4$  inch for the line of cells. Cells and counter cells shall be level. Gauge by eye along top edges for proper appearance, and at sides which should be approximately vertical and uniformly spaced. Slight irregularities of floor or cell may be compensated for by using, under the cells, shims made of thin strips of rubber or plastic preferably of the type used on battery stands. If more than slight shimming is necessary because of floor condition, the floor shall be leveled. Sides of large cells (KS-5562) that are slightly out of plumb or bulging slightly are considered acceptable.

4.06 KS-5562 cells, having soft rubber pads on the bottom, are to be placed in position using the battery lifting device designed for that purpose. Do not try to lever, skid, or slide the cell into position. If ordered as part of the battery equipment, the lifting device shall be turned over to the telephone company.

4.07 Floor plans for floor-mounted cells will have rectangles corresponding to the maximum dimensions permitted for the battery. When installed, the cells which may be considerably smaller, shall be located symmetrically on the longitudinal center line of the rectangle. Unless otherwise specified in the job information, the cell at one end (either end) of the rectangle shall be located with its transverse center line  $9-1/16$  inches from the end of the rectangle. Standard spacing, see 4.08, will locate the other cells. Floor plans for shelf- or rack-mounted cells will have rectangles corresponding to the cabinet or rack. Unless otherwise specified in job information, the cells shall be located symmetrically in the space reserved for them on such shelf or rack.

4.08 Spacing in Rows: Either the cell center to center or the terminal post face to face (adjacent faces) values listed below may be used to locate cells. In general, they are determined by the dimensions of the rigid intercell connectors. Other cells or cell combinations or groups of cells should have approximately  $3/8$  to  $5/8$  inch between cells or boxes, crates, etc.

Cell	Cell C-to-C (Inches)	Post Face To Face (Inches)
Cells mounted with plates <u>perpendicular</u> to stand length		
KS-5553		
KS-15544		
List 310	11-1/2	3-3/4
List 311	11-1/2	3-3/4
List 402	5-5/8	4-7/8
List 403	6-5/8	5-5/8
List 405	8-1/2	7-1/2

Cell	Cell C-to-C (Inches)	Post Face To Face (Inches)
Cells mounted with plates <u>parallel</u> to stand length		
KS-5170		
Lists 101, 130	5-1/4	4-3/8
List 102	7-5/8	6-3/4
Lists 103, 131	10-5/8	9-3/4
List 106, 110, & 140	13	8

KS-5553		
KS-15544		
Lists 407, 409	11-1/4	4-1/16
Lists 501 to 508	15	6-1/2
KS-5562		
All lists	18-7/16	7-5/16
KS-5170		
Lists 101 to 103, 130, 131	8-5/8	3-1/4
Lists 106, 110, 140	11-1/8	5
List 120 (intermittent)	15	6-1/2
List 120 (continuous)	15-5/8	7-1/8
Lists 150, 151	15	6-1/2

In this connection, loading of counter cells for more than 8 hours at a time is considered continuous and for less time is considered intermittent. The clearance between KS-5170, List 120 counter cells and adjacent storage cells shall be at least 3 inches when loading is continuous and 1 inch when loading is intermittent.

4.09 The spacing between rows of containers shall be at least  $3/4$  inch, except on large cells (KS-5562) on which it shall be at least 3 inches.

4.10 Exposed surfaces of unpainted bolts and nuts used to fasten bus bars, cable racks, or other framework to battery racks or stands shall be finished to match the adjacent surface.

### 5. PREPARATION OF CELLS

5.01 Before installing counter cell elements in the jars, see that the nuts which hold the plate groups in position are securely tightened on the terminal posts. Instructions on preparing alkaline solution and filling counter cells are outlined in Section A401.004. No sealing compound shall be used to attach the cover to the jar. After assembly and connection of counter cells, the entire terminal post and bolt assembly projecting from the cover shall be covered with silicone compound. The inside of the unused bolt hole and the surface of the bolt going across it shall also be covered with silicone compound. Counter cells do not require charging. Vent plugs for counter cells should be discarded.

5.02 Interconnection of battery cells before installation of accessories such as filling funnels, level indicators, etc., on the top of the cell, may facilitate the work by avoiding the interference of such accessories with the use of wrenches. With such order of procedure, the shipping plugs shall be left in place while the cells are being interconnected. This is to reduce the chance for an explosion. If, on the other hand, the plugs are removed and the accessories installed before the work of interconnecting the cells, the electrolyte in the cells with antiexplosion features shall be at the minimum level or higher during this operation to assure functioning of the antiexplosion feature.

5.03 Coat threads of connector bolts of battery cells with silicone compound and partially fill (1/8 to 1/4 full) the bolt hole in the terminal post before inserting the bolt. Silicone compound will not harm plastic. After completing connection, wipe off excess compound. It is not recommended that compound be placed in the unused bolt hole in terminal posts having two holes, unless it is known that the metal is broken through at the crossing of the bolt holes. In this case, fill the unused bolt hole with compound.

5.04 Larger cells are usually interconnected by lead-plated details made by the battery manufacturer. Smaller cells are usually interconnected by terminal lugs and rubber-covered leads prepared by the battery manufacturer. Connections prepared on the job may be made preferably with lead-coated copper or with lead-alloy terminal lugs and rubber-covered cable, stranded preferred. The size of lead may be the same as the lead running to the battery, except that for 100-ampere-hour and smaller cells, the lead need not be larger than No. 8.

5.05 Some shipping plugs, such as those on KS-15754, and Exide 50- and 100-AH cells, are designed for permanent use in the top of filling funnels as spray caps. Others, originally meant for discard, are now used by some telephone companies permanently in the vents to prevent dirt or other foreign matter from entering the cells. For this reason, all shipping plugs for battery cells shall be turned over to the telephone company.

5.06 The ends of the flexible nozzles of the hydrometers shall be cut off so that they extend just below the minimum level line. This will reduce the tendency of the hydrometer to throw electrolyte when moved from cell to cell or from holders and permit permanent mounting on a pilot cell, if desired. A convenient means of obtaining the correct length of flexible nozzle where the cells have removable filling funnels is as follows. Before installing all of the filling funnels, insert the hydrometer in

one of them as far as it will go and cut off the flexible nozzle 1/16 to 1/8 inch beyond the funnel end.

5.07 Install all vent and filling funnels, if shipped separately. (See 5.06.) Install spray cap, if any. (See 5.05.) With porous vents shipped in place, remove tape and packing used to block them during shipping. Where there is a choice, locate the filling funnel on the side most accessible for water additions. Lead-antimony funnels shall not be installed in cells (KS-15544) with lead-calcium grids. Gould and Exide lead-calcium funnels have a green or blue distinguishing band and their lead-antimony funnels have no marking. All C & D lead-alloy funnels are of lead-calcium, so require no distinguishing band. Plastic funnels are unmarked and may be used interchangeably. Install level indicator, if any. Check it by depressing with the finger to be sure it is not sticking. Check electrolyte level. (See 2.04.)

5.08 In no case shall paint or grease be applied to any porous ceramic part.

5.09 Where overflowing is experienced on initial charge of any cells having removable porous ceramic vents, the vents in question shall be washed in water to remove acid, dried as far as practicable, and reinstalled. The vents shall not be excessively wet with electrolyte as this will block the pores.

5.10 In the past, a small rubber collar was usually shipped with each battery thermometer. These were to be slipped on the lower end of the thermometer and serve, on the smaller cells at least, to position the thermometer in the cell and make it stand upright. Future thermometers with barrels of uniform diameter will have no rubber collar. They will be inserted until they rest on the plates or separators and when left in the cell, they will stand at an angle instead of being perpendicular. The older instruments were special and had an enlarged upper section to permit showing 4-digit specific gravity correction values, for example, +0.002. The new instruments are standard laboratory thermometers with single-digit specific gravity correction values, for example +2, which means two points or 0.002 specific gravity. The new instruments will be more convenient to use and less breakage is anticipated.

## 6. INITIAL CHARGE - GENERAL

6.01 During the initial charge the pilot cell shall be the new cell with the lowest specific gravity, except that it shall not be a cell next to a window or hot radiator or a cell at the end of a row. Any cell, whose specific gravity before the initial charge is too low to read on the standard hydrometer, may be assumed to be

the lowest cell and used as its pilot cell for the initial charge. One pilot cell per string is required. It is not necessarily the permanent pilot cell.

6.02 Charging parallel strings of different ages is sometimes unavoidable where a new string is being added in a working office and where using temporary charging equipment or running temporary charging leads from the office charging equipment to the new string is not feasible. The old string would then receive more charge than was necessary or desirable. When connecting strings, they should be at approximately the same voltage to avoid arcs. This can be accomplished either by allowing the higher voltage string to discharge until the desired voltage is reached, or by charging the low voltage string as required. Where feasible, the change in connections should be made at some point other than the battery terminals, possibly with switch at some distance from the cells. If connections are changed at the battery, care should be taken to avoid explosions. Changes should be made with the charger shut down or just carrying the load, if any. Connections should not be made while the cells are gassing violently.

6.03 Where one or more cells are added to a charged string, it would be preferable to give the initial charge to the added cell or cells only. Where a single-cell charger is not available or for other reasons this is impracticable, it will be necessary to give the charge to the entire string using one of the added cells as the pilot cell and basing length of charge per the tables on the voltage of the pilot cell instead of the voltage of the string.

6.04 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.

#### 7. ELECTROLYTE LEVEL (Low-gravity Cells Shipped Filled)

7.01 Check electrolyte level of all cells just before the start of the initial charge. (See 2.02 to 2.04.)

7.02 If necessary, to prevent overflow, electrolyte shall be removed from the cells during the charge. Level may do higher than the maximum level during charge, but overflow is not expected with these routines.

7.03 During the last quarter of the initial charge, add approved water as necessary to bring level up to specified maximum. Electrolyte need not be removed to reduce the level to the maximum level, unless this is necessary to prevent overflow. Final leveling toward end of charge, after cells are up to maximum temperature and after trapped gas lost during shipment has been replaced, aims to avoid overflow. Final leveling before end of charge takes advantage of the mixing action of the end of charge gassing.

#### 8. TYPES OF INITIAL CHARGE (Low-gravity Cells Shipped Filled)

8.01 The initial charge may be either to a measured end per Table A or of arbitrary length per Table B as selected by the installer or as directed locally. It should be at a value between 2.20 to 2.70 volts per cell, but preferably from 2.30 to 2.70.

- Charging rate should not exceed the finishing (nominal charging) rate, except during the early part of the charge when as high as 150 per cent of the finishing rate is acceptable, provided there is no cell overflow and electrolyte temperature is not excessive. Note that pilot-cell readings used in connection with Tables A and B need not be corrected for temperature. The initial charge of low-gravity lead-acid engine-starting batteries may consist of a 100 per cent of capacity charge as called for in most engine sections or, if preferred, the initial charge may be per Tables A or B as covered herein. For high-gravity engine-starting batteries see Part 12.

8.02 The total time a cell shipped filled stands on open circuit, that is, is not connected to suitable float or charging voltage, shall not exceed three months. If initial charge cannot be given within three months after shipment, the excess over the three months on open circuit can sometimes be avoided by floating the battery at 2.15 to 2.19 volts per cell, 24 hours a day, charging at 2.20 to 2.30 volts per cell, 7 or 8 hours a day, five days a week, or by giving a boost charge per 9.07 every six to eight weeks. Where none of these three methods is feasible, and open circuit has been from three to six months, the telephone company shall be notified and the regular initial charge shall be given except that:

(a) Voltage shall be between 2.30 and 2.40 volts per cell.

(b) Hours of stability for a charge to measured end shall be three times the values shown in Table A.

(c) The total hours of a charge of arbitrary length shall be one and one-half times the values shown in Table B.

Special charging may not compensate entirely for long periods on open circuit especially

VOLTS PER CELL	PILOT CELL ELECTROLYTE TEMPERATURE F										
	105	100	95	90	85	80	75	70	65	60	55
	TOTAL HOURS CHARGE AT STABILIFY										
2.70	4	4	4	4	4	4	4	4	4	4	4
2.64											
2.63	4	4	4	4	4	4	4	4	4	4	5
2.62	4	4	4	4	4	4	4	4	4	4	5
2.61	4	4	4	4	4	4	4	4	4	4	6
2.60	4	4	4	4	4	4	4	4	5	6	7
2.59	4	4	4	4	4	4	4	5	6	6	8
2.58	4	4	4	4	4	4	4	5	6	7	9
2.57	4	4	4	4	4	4	5	6	7	8	10
2.56	4	4	4	4	4	5	5	6	7	9	11
2.55	4	4	4	4	4	5	6	7	8	10	12
2.54	4	4	4	4	5	6	7	8	9	11	13
2.53	4	4	4	4	5	6	8	9	10	12	15
2.52	4	4	4	5	6	7	8	10	12	14	17
2.51	4	4	5	6	7	8	9	11	13	15	18
2.50	4	4	5	6	7	9	10	12	15	17	21
2.49	4	5	6	7	8	10	12	13	16	19	23
2.48	5	6	7	8	9	11	13	15	18	21	26
2.47	5	6	8	9	10	12	14	17	20	24	29
2.46	6	7	8	10	12	14	16	19	23	27	32
2.45	7	8	9	11	13	15	17	22	26	30	36
2.44	7	9	11	13	15	17	20	25	29	33	40
2.43	8	10	12	13	17	18	23	27	32	37	45
2.42	9	11	13	15	17	21	25	30	37	42	50
2.41	10	12	14	17	20	23	28	33	40	47	56
2.40	12	13	16	18	23	27	31	37	45	52	63
2.39	13	15	17	22	25	29	35	41	50	58	70
2.38	14	16	20	23	28	33	40	46	57	65	78
2.37	16	18	23	26	31	37	45	53	65	72	87
2.36	17	21	25	30	35	42	50	60	71	81	98
2.35	20	24	28	33	40	46	57	67	80	92	110
2.34	23	26	32	36	44	51	62	72	90	102	122
2.33	25	28	35	40	48	58	70	80	100	115	133
2.32	28	33	40	46	55	65	78	90	110	128	149
2.31	31	37	45	51	62	72	88	100	125	145	173
2.30	35	41	50	60	70	80	100	120	140	160	193
2.29	40	47	55	65	78	90	115	132	160	180	215
2.28	44	52	61	72	85	100	125	145	175	200	240
2.27	50	58	70	80	95	115	135	165	200	225	270
2.26	55	65	78	90	110	130	150	185	220	250	300
2.25	62	72	88	105	125	145	175	200	250	285	345
2.24	70	82	100	120	140	165	195	240	282	315	380
2.23	80	92	115	130	150	180	220	260	320	355	430
2.22	88	105	125	145	175	210	245	290	350	400	480
2.21	100	120	140	165	180	230	270	310	380	445	535
2.20	110	130	150	180	220	250	300	350	425	500	600

Table A - Hours of Stability of Charge to Measured End

with high electrolyte temperature, so that some loss of total cell life is to be anticipated under such conditions. Disposition of cells which have stood on open circuit for more than six months shall be discussed through normal channels.

8.03 Initial charge recommendations given herein for cells shipped filled do not apply if more than 1/2 inch of the top of the plates has been exposed to air for more than 20 minutes. (See 2.01.)

VOLTS PER CELL	PILOT CELL ELECTROLYTE TEMPERATURE F										
	105	100	95	90	85	80	75	70	65	60	55
	TOTAL HOURS CHARGE OF ARBITRARY LENGTH										
2.70	5	5	5	5	5	5	6	8	9	11	14
2.69	5	5	5	5	5	6	7	8	10	12	15
2.68	5	5	5	5	5	6	8	9	11	13	17
2.67	5	5	5	5	6	7	8	10	12	14	18
2.66	5	5	5	5	6	8	9	11	13	16	20
2.65	5	5	5	6	7	8	10	12	14	18	23
2.64	5	5	5	6	8	9	11	13	16	19	24
2.63	5	5	6	7	8	10	12	15	18	21	27
2.62	5	5	6	8	9	11	14	16	20	24	30
2.61	5	6	7	8	10	12	15	18	22	26	33
2.60	5	6	8	9	11	14	17	20	25	29	37
2.59	6	7	8	10	12	15	18	22	27	32	40
2.58	6	7	9	11	13	16	20	24	28	35	44
2.57	7	8	10	12	15	18	21	26	32	38	49
2.56	7	9	11	13	16	20	25	30	35	42	54
2.55	8	10	12	14	18	22	27	33	37	47	59
2.54	9	11	13	16	20	25	30	35	42	51	64
2.53	10	12	14	18	23	27	33	40	47	57	72
2.52	11	13	16	20	25	30	35	45	50	62	79
2.51	12	15	18	22	27	33	40	48	60	69	87
2.50	14	16	20	25	30	37	45	55	65	76	96
2.49	15	18	23	27	33	40	50	60	70	84	107
2.48	16	20	25	30	36	45	53	65	75	93	117
2.47	17	23	27	33	40	50	60	70	85	105	130
2.46	19	24	28	35	44	52	65	75	95	115	140
2.45	21	26	32	40	47	60	70	85	100	125	160
2.44	23	28	35	42	52	65	78	95	115	140	175
2.43	25	32	38	45	60	70	90	110	130	150	190
2.42	28	35	42	52	65	80	95	115	140	170	215
2.41	31	38	47	58	70	90	110	130	150	185	235
2.40	35	43	52	65	80	100	120	140	170	205	260
2.39	38	48	58	70	90	110	130	160	190	225	290
2.38	41	50	63	75	100	120	140	170	200	250	315
2.37	45	55	68	82	105	130	160	190	230	275	350
2.36	50	60	75	90	118	140	170	200	250	300	385
2.35	55	68	81	100	130	160	190	230	280	340	430
2.34	60	75	90	115	140	175	200	250	300	375	470
2.33	68	85	100	130	160	190	220	280	325	410	520
2.32	75	92	115	140	170	210	250	300	370	450	550
2.31	82	100	130	150	190	240	280	330	400	500	630
2.30	90	110	140	170	210	250	300	360	450	550	690
2.29	100	125	150	190	235	280	340	400	500	610	770
2.28	110	135	170	200	250	300	360	450	520	670	850
2.27	122	150	185	235	280	340	400	480	580	740	940
2.26	135	170	200	250	300	375	450	520	650	820	1040
2.25	150	190	220	280	340	425	500	600	750	900	1140
2.24	165	200	250	300	375	450	550	660	800	1000	1250
2.23	180	230	260	340	410	500	600	730	880	1100	1390
2.22	200	250	300	375	450	580	680	800	1000	1230	1540
2.21	230	280	340	400	500	650	750	900	1100	1350	1700
2.20	250	300	375	450	570	700	820	1000	1250	1500	1880

Table B - Total Hours of Arbitrary Length Charge

Initial Charge to Measured End (Table A)

8.04 After charging until the current, voltage, and pilot cell specific gravity are stabilized, continue to charge for the number of hours shown in Table A for the pilot cell voltage or the average voltage and also the pilot cell temperature present at the start of the period of

stability. If readings are taken hourly, note that five constant readings represent only four hours of stability.

(a) If the voltage is held as nearly constant as practicable, the period starts when the current is no longer decreasing and specific gravity is no longer increasing.

(b) If the current is held as nearly constant as practicable, the period starts when both the voltage and specific gravity are no longer increasing.

8.05 If the charge is interrupted, for a period not to exceed three days at a time during the period of stability, the battery should be brought back to stability at the same voltage after the interruption and the time of stability before and after the interruption should be added together. Disregard the temperature after the interruption.

Example: Assume that battery voltage is brought up to 2.40 volts per cell and held at this value until current and specific gravity stabilize, at which time electrolyte temperature is 90F. From Table A, 18 more hours of charge at 2.40 are required. If it is necessary to interrupt the charge after 11 hours of stability, the battery shall be charged after the interruption until again stabilized at 2.40 volts and the charge then continued for 7 hours.

#### Initial Charge of Arbitrary Length (Table B)

8.06 With regulated charger, charge until voltage is up to the value at which it is to regulate during the charge. After reaching regulated voltage, charge for the number of hours indicated in Table B for that voltage and for the pilot cell temperature then present or, if desired, hold at charge voltage for a time to permit the electrolyte to warm up and then charge for the number of hours indicated in Table B for the voltage and for the pilot cell temperature after the warm up. Delaying start of the charge per Table B until cells are warmer will sometimes save over-all time.

8.07 With an unregulated charger, charge for 3 hours and note voltage. If the pilot cell voltage or average voltage is 2.20 or higher, continue the charge with same charger setting for the number of hours indicated in Table B for that voltage and the pilot cell temperature then present. If voltage is less than 2.20 per cell, at the end of the 3 hours, continue the charge until a voltage of 2.30 to 2.35 per cell is reached and then apply Table B. Periodic adjustments of charger output to hold current as high as permitted are acceptable until Table B is put into effect, after which charger should not be readjusted.

Example: Assuming that the voltage per cell at end of third hour with unregulated charger is 2.65 volts with 70F electrolyte, then, from Table B, the charge should be continued for 12 hours at same charger setting.

8.08 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 as mentioned in 8.06, 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 B. Note that time in Table B is for hours of charge, not number of hourly readings.

8.09 Charger output shall not be reset or avoidable changes made in the charging circuit conditions during the time a charge per Table B is being applied.

#### End of Initial Charge

8.10 Record individual cell temperature and voltage, as well as charging current in amperes, just before charge is stopped. No cell voltage at charge value corrected for temperature (see 1.07) shall be more than 0.10 volt above or more than 0.06 volt below the average. If a cell or cells are out of 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. Cells out of limits after two full initial charges are unsatisfactory and should be discussed through normal channels.

#### 9. FROM INITIAL CHARGE TO TURNOVER (Low-gravity Cells)

9.01 From initial charge to turnover, the battery should be maintained in accordance with the associated operating section. With a battery that is to be floated, if 24-hour float at 2.17 volts per cell is impracticable, charge all of each working day at 2.20 to 2.30 volts per cell with no load or negligible load during the open-circuit period. A voltmeter drain is considered negligible but a control circuit drain is not. Special routines described herein for batteries that are to be floated may be followed, also if desired, on batteries that are not to be floated, but this is not required.

Note: If 24-hour float is inconvenient for the installer, but insisted on by the telephone company, or if 24-hour float is necessary because the batteries are supplying a night load at the request of the telephone company, then

night coverage by an attendant, if necessary, will be the responsibility of the telephone company. If charging generators are operated at light load during installation period, consider lifting some of the brushes as discussed in Section A401.101.

9.02 Record float- or maintaining-voltage and hours per week at this voltage. Record pilot cell voltage and corrected specific gravity weekly.

9.03 At least three working days after the initial charge of a battery that is to be floated and within a week before turnover, record individual cell corrected voltages on float after at least 5 hours of continuous float. (See 9.01.) No cell corrected voltage shall be more than 0.10 volt above or more than 0.04 volt below the average for the string. (See 1.07.) If a cell or cells are out of limits, give a boost charge per Table C, float the battery for three days, and recheck the corrected voltages on float after at least 5 hours of float. If they are still out of limits, the cells are unsatisfactory. Handle through normal channels. Note that cells which might otherwise meet limits may fail to do so if there has been any irregularity in battery maintenance, especially during the three days.

9.04 If time from initial charge to turnover exceeds six weeks, within a week before turnover, give a boost charge per Table C with no individual cell voltage readings required. Note that on a battery that is to be floated this boost charge is given if time exceeds six weeks, even if voltage readings per 9.03 are satisfactory. If a boost per 9.03 has been given, this boost is not required.

9.05 Record individual cell corrected specific gravities within a week before turnover. If there is a boost charge, these readings may be taken before, during, or after the charge.

9.06 If necessary to meet requirements, specific gravity should be adjusted. (See Section A401.001.) Before making any adjustment of electrolyte, be sure that the failure to meet requirements is not due to discharge of the cells, to the electrolyte in different cells being at different levels, to temporary stratification following the charge, to the recent addition of water in some cells, or to other irregularities which can be corrected. It may take two weeks after the charge for the specific gravity of lead-antimony cells to reach final value, and six weeks for lead-calcium. Where it is impracticable to give the initial charge and get final readings before turnover, discuss with the telephone company to see whether or not the installer will be required to return later to either take final readings or adjust electrolyte.

### Boost Charge (Table C)

9.07 If boost charge is required (8.02, 9.03, and 9.04), raise battery voltage to boost value and then charge for the number of hours indicated in Table C.

Examples: At 2.20 volts per cell, the length of charge would be 147 to 180 hours which is approximately one week of continuous charge. At 2.30 volts per cell, the time is 33 to 41 hours.

With electrolyte temperature above 95F the minimum length of boost charge is preferable, while at temperatures below 65F the maximum is preferable. Charges at temperature below 50F shall be avoided.

9.08 If the charge is interrupted, for a period not to exceed three days at a time, the battery should be brought back to the same voltage as before the interruption and the periods before and after the interruption added together.

### 10. RECORDS (Low-gravity Cells)

10.01 It is suggested that records be kept on form E-2003 or Western Electric Company form ID-1285. If there is not room on these forms, particularly for miscellaneous readings, form E-2004 or E-3592 may be found more convenient. Always record the time and date of starting and stopping a charge and of starting any readings which are recorded. Always record the temperature and uncorrected voltage and specific gravity readings on which required corrected values are based. (See 1.07.)

10.02 Record all changes made in electrolyte level of filled cells. The amount of water or electrolyte per cell added or removed may be given in pints, quarts, or in change in level in quarters of an inch. Record level of each cell as received.

Examples: One-half inch below top of plates, plates covered but below minimum, 1/4 inch below maximum.

10.03 Record condition of cells between receipt and initial charge.

Examples: Dry as shipped, open circuit, floated 24 hours a day at 2.17, 7 hours daily charge at 2.25, or boost charge every 6 weeks.

10.04 During initial charge to measured end, per Table A, record charging current, pilot cell (or battery) voltage, and pilot cell specific gravity at least hourly during the period before stability. After stability is thought to have been attained, the period between readings may be extended to possibly one-fourth or one-third of the specified period of stability for the voltage used. Where the specified period of stability exceeds 85 hours, daily readings are suggested.

VOLTS PER CELL	HOURS	
	MAX.	MIN.
2.60 TO 2.53	1.5	1.5
2.52	1.75	1.5
2.51	2.00	1.50
2.50	2.25	1.75
2.49	2.75	2.00
2.48	3.00	2.25
2.47	3.50	2.75
2.46	4.00	3.00
2.45	4.75	3.50
2.44	5.50	4.25
2.43	6.25	4.75
2.42	7.25	5.50
2.41	8.50	6.50
2.40	9.75	7.50
2.39	11.25	8.75
2.38	13.0	10.0
2.37	15.00	11.75
2.36	17.25	13.75
2.35	20.00	16.00
2.34	23.0	18.50
2.33	26.75	21.50
2.32	31.00	24.75
2.31	36.00	28.75
2.30	41.00	33.00
2.29	48.00	38.75
2.28	56.00	45.00
2.27	64.50	51.00
2.26	75.00	60.25
2.25	86.50	70.00
2.24	102.00	80.75
2.23	117.00	94.00
2.22	135.00	110.00
2.21	156.00	127.00
2.20	180.00	147.00

Table C - Boost Charge Time

10.05 During initial charge of arbitrary length, per Table B, record charging current, pilot cell (or battery) voltage, and pilot cell temperature at the following times.

- (a) At the start of the period of constant voltage when charge starts, per Table B.
- (b) Whenever charging rate or voltage is known to have changed appreciably.
- (c) Just before charge is stopped, due either to interruption or end of charge.
- (d) When charge per Table B is resumed, after an interruption.

↗ 10.06 During initial charge of cells shipped dry, record charging current, length of time of the 100 per cent charge, and record hourly the charging current, battery or pilot cell voltage, and the pilot cell specific gravity during the constant period.

10.07 Just before initial charge is stopped, record individual cell temperatures and voltage as well as charging current in amperes.

10.08 From initial charge to turnover, record float or maintaining voltage and hours a week on this voltage. Record pilot cell voltage and corrected specific gravity weekly.

10.09 Within a week of turnover, record individual cell corrected voltages on float of cells that are to be floated.

10.10 Within a week before turnover, record individual cell corrected specific gravities.

10.11 During boost charge, record pilot cell (or battery) voltage, time charge per Table C starts and stops.

10.12 Temperature readings should be to the nearest degree, for example, 75F; specific gravity or hydrometer readings to thousandths (points), for example, 1.212; battery voltage to tenths, for example, 50.0 volts; pilot cell or individual cell voltage to hundredths, for example, 2.17; and calculated average cell volts to thousandths, for example, 2.171.

↗ 10.13 Note in records any case where voltage or specific gravity readings uncorrected for temperature fail to meet requirements, but corrected readings meet requirements. In such a case, the telephone company may be able to improve local conditions. (See 4.01.)

10.14 Miscellaneous: Make note of items of special interest such as date of shipment, cells not gassing properly, plate exposure, if any, local conditions affecting temperature of cells, any cells which do not come within the authorized specific gravity range at the end of the charge, type of charger regulation, etc. Give reasons, if known, for any irregularities. The name of the telephone company, office, town, and state, the manufacturer's name and order number or serial number, and battery data, that is, number and type of cells, should be a part of the initial charge report.

10.15 Two copies of the initial charge report and the final adjustment of electrolyte report, if made, shall be turned over to the telephone company. It is strongly recommended that one of these copies be filed by the telephone company at the office as a permanent record to be maintained during the life of the battery. A third copy of the initial charge report for all cells larger than 100-ampere-hours capacity shall be forwarded by the installer to the battery manufacturing company.

11. LOW-GRAVITY CELLS SHIPPED DRY

- 11.01 The initial charge shall be given within one year after shipment.
- 11.02 Fill the cells to minimum level with the furnished electrolyte from 5 to 15 hours before start of the initial charge. Just before the start of the charge, add electrolyte, if necessary, to bring level up to minimum. Electrolyte as furnished may be slightly lower in specific gravity than the desired final value to compensate for some increase in specific gravity during the initial charge.
- 11.03 Just after the precharge leveling but before start of charge, check each cell with any available dc voltmeter to be sure all polarities are correct. Wrong polarity might be due to an installing error or to a marking error in the factory, because polarity cannot be checked during the period the plates are dry. Such errors can usually be corrected on the job.
- 11.04 Charge at 25 or 40 per cent of the 8-hour rate until 100 per cent of the 8-hour capacity has been applied. Fill with furnished electrolyte to maximum level and continue the charge until both voltage and specific gravity have ceased to rise, for 4 hours if at 40 per cent, or 6 hours if at 25 per cent.
- 11.05 Check individual cell corrected voltages per 8.10.
- 11.06 From initial charge to turnover, follow Part 9.
- 11.07 Within a week before turnover, check individual cell corrected specific gravities. These gravities should be from 1.195 to 1.225 with a maximum variation between cells of 10 points (0.010) for cells rated over 100 ampere-hours, or 15 points (0.015) for smaller cells. (See 9.06.)
- 11.08 Prepare records in accordance with Part 10.

12. HIGH-GRAVITY CELLS SHIPPED FILLED  
(KS-15754)

- 12.01 The initial charge shall be given within three months after shipment.
- 12.02 Add approved water to bring level up to minimum. Do not remove electrolyte to bring level down to minimum.

- 12.03 Start the initial charge at 0.50 or 0.25 ampere, as convenient. At the end of one hour, reset charger output to the original value. Then continue the charge without further adjustment of the charger output, for 12 hours if at 0.50 ampere, or for 24 hours if at 0.25 ampere.
- 12.04 From 2 to 4 hours before the end of charge, fill all cells to maximum level with approved water.
- 12.05 Just before end of charge, check individual cell voltages with a Model No. 931 voltmeter having a 0-3 scale. Discard any unit having a cell more than 0.10 volt above or more than 0.06 volt below the average for the five cells of the unit.
- 12.06 After completion of the charge, shake the unit to mix the electrolyte and water. Avoid spillage. Check individual cell specific gravities with an automotive battery-type hydrometer. The specific gravity shall be between 1.285 and 1.315. The variation between cells of the same unit shall not exceed 15 points (0.015).

Note: Neither voltage nor specific gravity readings need be corrected for temperature, unless they fail to meet limits uncorrected. Where practicable, it is desirable that the ten cells for the same battery meet the five cell limits given above.

- 12.07 The initial charge shall be repeated every three months until installation, unless the cells are floated during this period at 2.20 to 2.30 volts per cell. It is assumed that maintenance after installation will be per Section A301.865.
- 12.08 Record the following data.
- (a) Time and current rate.
  - (b) Individual cell voltage toward end of charge.
  - (c) Individual cell specific gravity and temperature of pilot cell after the charge.
  - (d) See 10.12 to 10.15.

12.09 This section does not cover the initial charge of special high gravity (usually 1.280 nominal specific gravity) cells furnished by the engine manufacturer with the engine. The initial charge of such batteries should be as specified in the associated engine section.