STORAGE BATTERIES
LEAD-ACID ENCLOSED TYPE
INSTALLATION

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1. GENERAL

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

1.02 This section is reissued to incorporate a Caution on spacing and arrangement of cells, data on hardened site installations, a Note on placement of intercell connectors, procedures for use of plastic filling funnels, procedures to be followed when cells cannot be given the initial charge within the specified time, information on types of charge to be used, and procedures for initial charge to a measured end. The table of contents has been expanded. Also added is data on low-gravity cells shipped dry. Since this is a general revision, change arrows are not included. This reissue does not affect Equipment Test List.

1.03 Cells for telephone batteries are usually shipped charged and filled with electrolyte of either low-specific gravity (nominal 1.210) or 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 (see 7.01 through 7.07).

1.04 Cells as referred to herein are storage cells, unless countercells are specifically mentioned.

1.05 New installations of KS-15544 lead-calcium and KS-5533 or KS-5562 lead-antimony batteries should be sized on the basis that only 75 percent of the rated capacity will be available at the end of the normal 15-year life.

1.06 General requirements and procedures for lead-acid storage batteries are contained in Section 157-601-701. Section 157-621-801 covers Replacement Parts and Procedures.

2. HANDLING OF CELLS

2.01 ***Shipping Pallets:*** Cells shipped on pallets should be left on their pallets until their final location is reached. However, the cell may be cut loose from the pallet and handled individually when necessary for reasons of either insufficient floor space or lifting equipment inadequate for handling the entire assembly at once.

2.02 ***Handling and Uncrating Care:*** Care shall be taken to avoid damage to battery or countercell containers. Glass and plastic containers are particularly sensitive to scratches and other external damage. After uncrating, protective coverings shall be used to prevent the container from coming in contact with hard materials, such

as bare floors, steel racks, miscellaneous metal parts, tools, etc.

2.03 ***Exposure of Plastic Containers to Solvents, Petrolatum, or Detergents:*** Avoid exposure of plastic containers to petrolatum or solvents such as kerosene, gasoline, petroleum spirits, cleaning compounds, commercial detergents such as Igepal C0-630, and the thinner in waxes and polishes. Such materials tend to produce crazing or cracks in plastic.

2.04 ***Limits on Scratches and Crazing at Installation:*** All scratches, crazing, and other visible damage to containers shall be noted in the records. The position and dimensions of each defect shall be recorded. (See Section 157-601-703.) It may be necessary to wait until the cell is being hoisted onto the rack to gauge scratches on the bottom of the cell. Examine each plastic jar bottom, sides, and cover to determine that there are no holes, chips, gouges, or scratches 1/64 inch deep or deeper. An R-3618 Scratch Depth Gauge may be used for checking gouges and scratches. Lightly draw the protruding edge of the gauge along the opening and if light cannot be seen between the heel of the gauge and the surface of the cell, the unit is defective and should be reported.

2.05 ***Handling Large Carboys of Electrolyte:*** The large carboys of electrolyte 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. Small containers of one-gallon size are generally used. Observe precautions under heading of "Electrolyte Corrosion and Bodily Protection" contained in Section 157-601-701.

2.06 ***Limits on Tipping of Cells:*** Enclosed cells may be tipped as much as 15 degrees from vertical provided they do not remain in a tipped position any longer than 20 minutes. However, large floor-mounted, enclosed cells, such as KS-5562, may be tipped as much as 30 degrees momentarily in order to pass through windows or to circumvent other obstructions.

2.07 ***Lifting Cells into Position:*** Cells having soft rubber pads on the bottom, such as KS-5562, shall be placed in position using the battery lifting devices designed for this purpose. Do not try to lever, skid, or slide the cell into position. If the lifting device is ordered as a part of the battery equipment, it shall be turned over to the operating company.

3. LOCATING

3.01 ***Exposure to Radiant Heat:*** Cells should not be exposed to direct heat radiation. If it is necessary to install batteries adjacent to radiators or where direct sunlight will fall on them or where there may be temperature differences due to the use of 3-tier racks, the telephone company shall be notified. The telephone company may wish to provide shields for the radiators, blinds for the windows, or special ventilation for the 3-tier racks.

3.02 ***Placement of Rubber or Plastic Sheets Under Cells:*** Where flexible sheets of semihard rubber or plastic are specified instead of plastic trays as a protective covering under cells, they shall be placed upon the shelves with the curl downward and without any coating or adhesive. As a temporary measure until the cells are placed, hold the ends of the sheets by pieces of wood held in place by "C" clamps.

3.03 ***Leveling and Aligning:*** 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 countercells 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 releveled. Sides of large cells (KS-5562) that are slightly out of plumb or bulging slightly are considered acceptable provided that they meet the criteria established in 3.06 and 3.07.

3.04 ***Installing Cells on Centerline and Separating Opposite Ends of String:*** Floor plans for floor-mounted cells will have rectangles corresponding to the maximum dimensions permitted for the battery. When installed, the cells 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

centerline 9-1/16 inches from the end of the rectangle. Standard spacing, see 3.06, will locate the other cells and prevent cells from touching each other.

Caution: Cells in a string must not be allowed to touch each other or the adjacent framework at any time, nor should a string be arranged in an U shape so that the first and last cells are in close proximity. The positive (+) and negative (–) ends of a battery string must not be adjacent.

3.05 ***Placing Cells in Shelves or Racks:*** 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 the shelf or rack. For detailed information on new battery stand equipment arrangements for 24- and 48-volt power plants which supply loads of 10 to 800 amperes, see Section 802-125-151 (J87122), Issue 3, Addendum 1 or higher.

3.06 ***Spacing of Cells:*** Either the cell center-to-center or the terminal post face-to-face (adjacent faces) values in the following list may be used to locate cells. In general, spacing is determined by the dimensions of the rigid intercell connectors. Otherwise cells, cell combinations, or groups of cells should have approximately 3/8- to 5/8-inch space between the top edge of cells, cases, or trays.

3.07 ***Spacing Between Rows:*** The spacing between rows of containers shall range from at least 3/4 inch on small cells to at least 3 inches on large cell such as the KS-5562.

CELLS	CELL CENTER-TO-CENTER (INCHES)	POST FACE-TO-FACE (INCHES)
Cells mounted with plates perpendicular 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
Lists 106, 110, 140	13	8
Cells mounted with plates parallel to stand length		
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 countercells 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 countercells and adjacent storage cells shall be at least 3 inches when loading is continuous and 1 inch when loading is intermittent.

4. PREPARATION OF CELLS AND ACCESSORIES

4.01 ***Countercells:*** Wet countercells have been manufacture discontinued due to the explosion hazard of the gas produced during normal operation. Solid state counter EMF cells are now available (see Section 157-322-701).

4.02 ***Storage Cell Accessories and Shipping Plugs:*** Interconnection of battery cells shall be made with the shipping plugs left in place. This will reduce the chance of explosion. Accessories, such as filling funnels and level indicators, should not be installed until all connections are made. This will facilitate the work, such as the use of wrenches, by avoiding the interference of the accessories. If the shipping plugs are removed the antiexplosion features (see Section 157-601-701) and all other accessories must be 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.

4.03 ***Disposition of Shipping Plugs:*** Some shipping plugs, such as those on the KS-15754 and most KS-5361 and KS-15886 cells, are designed for permanent use in the top of filling funnels as spray caps. Other, 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 shipped plugs for the battery cells shall be installed on the cells or turned over to the telephone company. Shipping plugs of KS-20106 (hardened site cells) should be left in place after cell installation.

4.04 ***Intercell Connectors:*** At no time shall battery intercell connectors be filed, scraped, sandpapered, or brushed with a wire brush as this will remove the protective lead coating. If necessary to apply NO-OX-ID A compound, use a typewriter brush or similar stiff brush to coat ***only the contact*** areas of posts and intercell connectors and threads of connector bolts with NO-OX-ID A (R-3266) compound. The entire intercell connector shall not be coated. See Section 157-601-701 for method of heating and applying NO-OX-ID A compound. Partially fill the bolt holes (1/8 to 1/4 full) in the post with NO-OX-ID A compound before inserting the bolts. After completing connections, wipe off excess compound with a KS-14666 cleaning cloth or equivalent. Place NO-OX-ID A compound in unused bolt holes in posts having two holes. Contact surfaces of intercell connectors between cells which are made up at the factory need not be opened by the installer for applying NO-OX-ID A compound. The post seal nuts on all cells should be checked to insure that they are tight.

4.05 Larger cells are usually interconnected by lead-plated copper 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 with lead-coated copper or with lead-alloy terminal lugs and rubber-covered cable, stranded preferred. Hardened site installation of the KS-20106 battery normally includes the KS-5499 List 5200 flexible terminal connector. The size of the 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.

4.06 ***Equalizing Voltages of Strings to be Paralleled:*** When connecting a string in parallel to another string, both should be at approximately the same potential to prevent arcing. String voltage can be equalized by either discharging the higher-voltage string or raising the voltage of the lower-voltage string. (See 5.04.)

4.07 ***Avoiding Sparks During Gassing:*** Connections shall not be made or opened while cells are gassing. (See the explosion prevention precautions described in Section 157-601-701.) The charger should be either shut down or adjusted to just carry the load, if any.

4.08 ***Installing Vents, Funnels, and Spray Caps:*** Install all vents and filling funnels (see 4.10), if shipped separately. Install spray cap, if any. With porous vents shipped in place, remove tape and packing used to block them during shipping.

4.09 ***Hydrometer Flexible Nozzle Length Determination:*** 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.

Caution: Hydrometers used in lead-antimony cells should not be used in lead-calcium

cells and vice versa since this would contaminate the electrolyte.

4.10 ***Use of Filling Funnels:*** 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 KS-15544 or other cells with lead-calcium grids and vice versa. Exide lead-calcium funnels have a green or blue distinguishing band and their lead-antimony funnels have no marking. All C & D and present production of Gould lead-alloy funnels are of lead-calcium, thus they require no distinguishing band, but may be marked in some cases. Plastic funnels are marked and may be used interchangeably. However, they should be rinsed with water prior to insertion in a cell of a different type. The shipping plugs of KS-20106 cells should only be removed to make water additions, then should be replaced. Install level indicator, if any. Check the level indicator by depressing with the finger to be sure that it is not sticking.

4.11 ***Electrolyte Spillage and Plate Exposure:*** Check electrolyte level of cells shipped filled immediately after unpacking. If possible, spillage should be noted before unpacking. Record any action taken in the initial change report.

(a) If indications of spilling during shipment are noted prior to acceptance from the carrier, it should be recorded on the bill of lading before signing.

(b) Cells are not acceptable that have had more then 1/2 inch of the top of their plates exposed for more than 20 minutes at any time prior to turnover. Such cells may have concealed damage which cannot be corrected. If plates cannot be physically viewed, ability to pick up electrolyte with a hydrometer is proof that the plates are covered.

(c) Electrolyte 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 cell 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.

(d) If it becomes necessary to return any filled cell to the manufacturer because of low electrolyte level, add water, if available, otherwise add water before shipment, as necessary, to bring electrolyte level to minimum, and note action taken in report to manufacturer.

4.12 ***Hardened Site Battery Installation:*** Hardened site batteries, such as the KS-20048 L1 and the KS-20106 L101 and L108 (see Section 157-601-701), are designed to better withstand the shock of nuclear blasts or earthquakes. Fig. 7 in Section 157-621-101 displays the KS-20048 L1 cell. Instructions are included with these batteries that will enable obtaining the full shock resistant capabilities of these batteries.

5. INITIAL CHARGE

5.01 ***Pilot Cell Designation:*** A new cell shall be designated as the pilot cell within each string. When cells are shipped charged and wet, the pilot cell shall be the cell having the lowest specific gravity before initial charge. Any cell whose specific gravity is too low to be read on a standard hydrometer may be assumed to have the lowest specific gravity. However, when cells are shipped charged and dry, any convenient cell may be designated as the pilot cell. One pilot cell per string is required. It is not necessarily the permanent pilot cell.

5.02 ***Pilot Cell Location Restrictions:*** Pilot cells shall not be located near a window, a radiator, or at the end of a row.

5.03 ***Charging Cells Added to a String:*** When one or more cells are added to a charged string, it is preferable to give the initial charge to the added cell or cells only. If this is impracticable, give the charge to the entire string using one of

the added cells as the pilot cell and basing the charge on the pilot cell voltage instead of string voltage.

5.04 When adding a new string in parallel to an older string, the initial charge should be given to the new string only, if office conditions permit. (See 4.06.)

5.05 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 overall 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.

5.06 ***Maximum Time Until Initial Charge of Cells Shipped Charged and Wet:*** The maximum time that a cell shipped charged and wet may stand on open circuit shall not exceed 3 months for lead-antimony cells or 6 months for lead-calcium cells. If the initial charge cannot be administered to cells shipped charged and wet within the time specified, one of the following procedures shall be followed. The choice of which procedure to be follow may be based on convenience.

(a) Maintain the battery on continuous float operation (see Section 157-601-301) until the normal initial charge can be administered.

(b) Charge a low-gravity battery at 2.17 to 2.20 volts per cell or a high-gravity battery at 2.35 to 2.40 volts per cell, 8 hours a day for 5 days a week until the normal initial charge can be administered.

(c) Give a boost charge (see Section 157-601-701) every 6 to 8 weeks until the normal initial charge can be administered.

5.07 ***Maximum Time Until Initial Charge of Cells Shipped Charged and Dry:*** For cells shipped charged and dry, the initial charge shall be administered within 1 year after shipment, and no more than 15 hours after filling. (See Part 7.)

5.08 ***Maximum Temperature During Initial Charge:*** Cell temperatures higher than 110°F are not permissible except during the last 3 hours of the initial charge. However, appreciably lower temperatures, 80°F or less, are preferred at all times.

5.09 ***Type Initial Charge Required Prior to Turnover to Operating Company:*** An initial charge shall be administered to all new lead-acid cells prior to turnover to the operating company. This charge shall be either to a "measured end" (see 5.17) or of "arbitrary length" (see 5.10). 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.

5.10 ***The Arbitary Length Charge:*** An 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 the plant cannot be operated at a battery potential above 2.20 volts per cell then the arbitrary length charge should be used.

5.11 The arbitrary length charge must be used when it is not practical to measure or accurately estimate the current going into the string.

5.12 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.

5.13 Since this charge is arbitrary, it supplies to every cell enough current over the required period of time to fully charge a battery in practically any condition of discharge. The measured end charge (see 5.17), however, supplies only sufficient current to restore the battery to a fully charged condition.

5.14 ***Procedure for Initial Charge of Arbitrary Length:*** With regulated charger, charge the battery until voltage is up to the value at which it is to regulate during charge. After reaching regulated voltage, charge for the number

of hours indicated in Table A for that voltage and the pilot cell temperature. 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 A for the voltage and pilot cell temperature after the warmup. Delaying start of the charge per Table A until cells are warmer will sometimes save overall time.

Example: A cell is to charge at a regulated voltage of 2.40 volts with the pilot cell electrolyte temperature stabilized at 90°F. Bring the cell voltage up to 2.40 volts. Assume the electrolyte temperature reaches and stabilizes at 90°F. Charge the cell at 2.40 volts for 80 hours.

5.15 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 5.14 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. Note that time in Table A is for hours of charge, not number of hourly readings.

Example: A cell is to charge at a regulated voltage of 2.30 volts with the pilot cell electrolyte temperature stabilized at 85°F. Bring the cell voltage up to 2.30 volts. Assume that the electrolyte temperature reaches and stabilizes at 85°F. After charging at this rate and temperature for 100 hours, the charge is interrupted. Before continuing the charge, bring the cell voltage back to 2.30 volts and with the electrolyte temperature at least as high as before the interruption, continue the charge at 2.30 volts for an additional 150 hours, making a total of 250 hours charge at 2.30 volts.

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

5.17 ***Conditions Requiring the Measured End Charge:*** The measured end charge is recommended where the cell voltage can be raised to 2.50 volts and the cells can be disassociated from the working equipment (see 5.05). 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 (see Table B) which assures full charge.

TABLE A — TOTAL HOURS OF ARBITRARY LENGTH CHARGE

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										
2.50	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	96	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	766
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	1360	1700	2040
2.20	300	375	450	570	700	820	1000	1250	1500	1880	2256
2.19	330	410	490	620	770	890	1110	1390	1650	2000	2460
2.18	365	460	545	685	860	990	1250	1540	1810	2210	2720
2.17	400	500	600	760	940	1100	1380	1700	2000	2420	3000

TABLE B — HOURS OF STABILITY OF CHARGE TO MEASURED END

VOLTS PER CELL	PILOT CELL ELECTROLYTE TEMPERATURE F										
	105	100	95	90	85	80	75	70	65	60	55
	TOTAL HOURS CHARGE AT STABILITY										
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

5.18 ***Procedure for Initial Charge to a Measured End:*** Start the charge. If the charging equipment is adequate, charge until the voltage limit of 2.50 volts per cell is reached. If the charge equipment is not capable of 2.50 volts per cell, charge at the maximum which shall be at least 2.40 volts per cell, otherwise, the charge must be given by the arbitrary length method.

5.19 Charge until the specific gravity is at least 1.180 for low-gravity cells or 1.275 for high-gravity cells and the current is no longer decreasing. After the current has stabilized continue to charge for the number of hours shown in Table B for the pilot cell voltage or the average cell voltage and also the pilot cell temperature present at the start of stability.

5.20 Guard against electrolyte overflow. If it should become necessary to remove electrolyte to prevent overflow, make note of removals on installation records. Retain electrolyte for possible reuse. See Part 9 for records which must be maintained.

5.21 ***End of Initial Charge:*** At the end of the initial charge, 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 shall be more than 0.10 volt above or below the average. If a cell or cells are out of these limits at end of the initial charge, give a second initial charge. Cells out of limits after two full initial charges are unsatisfactory. See Part 9 for records which must be maintained.

6. FROM INITIAL CHARGE TO TURNOVER

6.01 From initial charge to turnover, batteries shall be maintained in accordance with the standard operating routine which will be used after cutover. The pilot cell uncorrected voltage and pilot cell corrected specific gravity readings shall be performed weekly; and the maximum interval between all other readings and inspections shall be 1/2 of the time stated in Section 157-601-701. Any deviation from this requirement shall be upon consent of the operating company.

6.02 At least 3 working days after the initial charge of a battery that is to be floated after turnover and within a week before turnover, record individual cell corrected voltages on float after at least 5 hours of actual continuous float at 2.17 volts per cell. No cell-corrected voltage shall

be more than 0.10 volt above or more than 0.04 volt below the average for the string. If a cell or cells are out of limits, give a boost charge (see Section 157-601-701), float the battery for 3 days, and recheck the corrected voltages on float after at least 5 hours of float. It is quite probable that cells no more than 0.06 volt below the average will pull into line in a few weeks of normal operation. It is recommended that cells more than 0.04 volt below the average but not more than 0.06 volt below the average be discussed with the telephone company who should be willing to accept such cells tentatively with the understanding that the installer will reassume responsibility if the battery fails to be within 0.04 volt after 10 weeks of normal operation. If the operating company accepts the battery before the end of the initial charge or while some cells are still out-of-limits, the installer retains responsibility for the cells for a period of 10 weeks after completion of the initial charge. In those cases, however, where the installer completes the initial charge and the cell readings are within limits, the battery may be turned over to the operating company 72 hours after completion of the initial charge.

6.03 To replace cells which were accepted before turnover but found to be out of limits after the 10-week period on normal float operation, the telephone company should issue a nonbillable furnish and install requisition on the Western Electric Co. Distributing House worded as follows:

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

This requisition and complaint should be cross-referenced, and all papers should bear reference the P.E.M 7101 and the engineering complaint number ED-129800. Formal engineering complaint papers are not required.

6.04 The full-charge ***specific gravity*** for 15-ampere-hour and larger cells should be from 1.185 through 1.225 and the variation between cells shall not exceed 15 points (0.015). An exception is that on cells with charge indicators, the full-charge specific gravity shall be sufficient to float all indicator balls. Where initial charge is at 2.35 volts per cell or higher, the check of specific gravity in connection with the above requirements should be approximately 1 week after the initial charge. On charges at lower voltages, the check should be about 2 weeks after initial charge for antimony cells and 6 weeks after for calcium cells.

7. LOW-GRAVITY CELLS SHIPPED DRY

7.01 The initial charge shall be given within 1 year after shipment.

7.02 About 10 or 15 hours before start of the initial charge, fill to minimum level with electrolyte 1.210 $\pm$0.010 specific gravity at any temperature from 60 to 90°F. Just before the start of the charge, add electrolyte, if necessary, to bring level up to minimum.

7.03 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 installation 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.

7.04 Charge at 25 or 40 percent of the 8-hour rate until 100 percent of the 8-hour capacity has been applied. Fill to minimum level with approved water. Fill with electrolyte to maximum level and continue the charge until both voltage and specific gravity have ceased to rise, for 4 hours if at 40 percent, or 6 hours if at 25 percent.

7.05 Check individual cell corrected voltages per 5.21.

7.06 From initial charge to turnover, follow Part 6.

7.07 Prepare records in accordance with Part 9.

8. KS-15754 HIGH-GRAVITY CELLS SHIPPED FILLED

8.01 The initial charge shall be given within 1-1/2 months after shipment.

8.02 Add approved water to bring level up to minimum. Do not remove electrolyte to bring level down to minimum.

8.03 With a wire, bent as required, check that the small horizontal vent holes in the vent tube are not clogged with grease.

8.04 Start the initial charge at 0.50 or 0.25 ampere, as convenient. At the end of 1 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.

8.05 From 2 to 4 hours before the end of charge, fill all cells to maximum level with approved water.

8.06 Just before end of charge, check individual cell voltages with a model No. 931 voltmeter having a 0 to 3 scale. Discard any unit having a cell more than 0.10 volt above or below the average for the five cells of the unit.

8.07 After completion of 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 5-cell 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 in 8.06 and 8.07.

8.08 The initial charge shall be repeated every 3 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 167-275-301.

8.09 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 9.10 through 9.13.

9. RECORDS (Low-gravity Cells)

9.01 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.

9.02 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.

9.03 Record conditions of cells ***between receipt and initial charge.***

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

9.04 ***During initial charge of arbitrary length,*** per Table A, 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 A

(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 A is resumed, after an interruption.

9.05 ***During initial charge to measured end,*** per Table B, 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 1/4 or 1/3 of the specified period of stability for the voltage used. Where the specified period of stability exceeds 85 hours, daily readings are suggested.

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

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

9.08 From ***initial charge to turnover,*** record float or maintaining voltage. Record pilot cell voltage and corrected specific gravity weekly.

9.09 ***Within the week prior to turnover,*** record individual cell corrected voltages on float of cells that are to be floated and individual cell corrected specific gravities.

9.10 Temperature ***readings*** should be to the nearest degree, for example, 75°F; specific gravity or hydrometer readings to thousandths (points), for example 1.212; battery voltage to tenths, for example, 49.9 volts; pilot cell or individual cell voltage to hundredths, for example, 2.17; and, calculated average cells volts to thousandths, for example, 2.171.

9.11 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.

9.12 ***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 cell which does not come within the authorized specific gravity range, type of charger, and regulation. 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.

9.13 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-hour capacity shall be forwarded by the installer to the battery manufacturing company.