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STORAGE BATTERIES

LEAD-ACID TYPE

1. GENERAL

1.01 This section covers lead-acid-type storage batteries of the low gravity (nominal 1.210 specific gravity) type usually used in telephone power plants. It also covers high gravity (nominal 1.300 specific gravity) batteries of the type sometimes used in outdoor locations. It does not cover special high gravity (nominal 1.280 specific gravity) batteries furnished by some engine manufacturers with engines, usually engines of the portable type. For information on such special engine starting batteries, see the associated engine section. For additional information primarily applicable to open-tank type batteries, see Section A401.005.

1.02 This section is reissued:

- (a) To include KS-15754 high gravity cells.
- (b) To add additional antiexplosion suggestions.
- (c) To add further information on correcting readings for temperature.
- (d) To add information on electrolyte around terminal posts.
- (e) To add method of checking electrolyte level of inaccessible cells.
- (f) To remove instructions, now in Section A501.925, on action to be taken in case of damage by flood water.

1.03 Information is arranged under the following headings:

1. GENERAL

2. REQUIREMENTS

- 2.01 Initial Charge Voltage
- 2.02 Turnover Voltage
- 2.03 Cell Voltages During Life
- 2.04 Temperature of Electrolyte
- 2.05 Temperature Variations
- 2.06 Freezing Temperatures
- 2.07 Level of Electrolyte During Installation
- 2.08 Level of Electrolyte During Life
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- 2.12 Specific Gravity After Adjustment Upwards
- 2.13 Capacity
- 2.14 Battery Connections
- 2.15 Posts
- 2.16 Containers
- 2.17 Covers
- 2.18 Moss
- 2.19 Sulfate
- 2.20 Sediment
- 2.21 Plates
- 2.22 Battery Racks, Stands, etc.
- 2.23 Ceramic Parts
- 2.24 Level Indicator Floats
- 2.25 Filling Funnels
- 2.26 Ventilating and Draining Battery Room
- 2.27 Floors, Walls, Ceilings, etc.

3. ADJUSTING PROCEDURES

1.04 Gould cells will have a letter D, T, or K in addition to the word GOULD on each cell to indicate manufacture at the Depew, Trenton, or Kankakee factory. On records and correspondence, the D, T, or K or the factory name should be included whenever a Gould cell is mentioned.

1.05 Reference shall be made to Section A400.001 covering general requirements and definitions for additional information necessary for the proper application of the requirements listed herein.

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

Caution B: Precautions which may be deemed necessary, such as the use of gloves, apron, and goggles, shall be employed in the handling of the electrolyte and cells containing electrolyte. Wrenches used on cells should be insulated. Connections should be changed only while cells are not gassing.

Caution C: Avoid exposure of plastic containers to petrolatum or solvents such as kerosene, gasoline, petroleum spirits, the solvent in most cleaning compounds, and the thinner in most waxes and polishes. Petrolatum and such solvents tend to produce cracks or crazing in plastics.

1.06 Regarding possibility of explosion, there are four general types of cells, namely:

- (1) Open cells.
- (2) Cells with explosion-proof covers, such as KS-5553, KS-5553-01, KS-5562, KS-15544, and recent Exide 50- and 100-ampere-hour cells per KS-5361.
- (3) Cells with KS-5499, Lists 1270, 1270A, 1270B, and 1271, explosion-proof vents.
- (4) Enclosed cells with no antiexplosion feature. These cells are usually of 30-ampere-hour capacity or less.

The first three require no special operating precautions other than reasonable care, proper ventilation of rooms and battery cabinets, and rigid enforcement of the minimum electrolyte level requirement. The fourth requires additional precautions. (See 1.07 and 1.08.)

1.07 If it is necessary to open the circuit at the battery or use an open flame or tool likely to draw arcs or cause sparks near an enclosed cell with no antiexplosion feature or where the antiexplosion feature is not in place or is temporarily inoperative, first, provide maximum permissible ventilation for battery room or battery cabinet. Second, allow the cells to remain at least half an hour on open circuit or at float voltage. (During this period vent plugs, if used, of cells with no antiexplosion feature should be removed, but attendant should ground himself momentarily before removing the plug.) (See 1.08.) Third, cover aisle sides of the cell and of adjacent cells in the same row with several thicknesses of wet cloth to limit the damage in the unexpected occurrence of an explosion. Adjacent counter-cells should have the aisle side and the space between cells protected with wet cloth. Care should be taken not to cover cells or counter-cells so that venting is obstructed. The precautions of this paragraph do not apply to the careful use of voltmeter test picks.

1.08 As a precaution against an explosion caused by a static spark while taking hydrometer or thermometer readings on cells with no antiexplosion feature or when installing new vents of any type in cells in service, first ground self by touching the hand to a cell terminal near the grounded end of the battery. If a ground or near ground terminal is not within reach, a higher voltage terminal may be touched with the hand protected by two thicknesses of dry cloth. Static electricity may be expected on the body after walking across a floor, particularly when the floor is covered by rugs, linoleum, or rubber or asphalt tile and the atmosphere is dry. Then remove plugs, if any, and leave out 2 or 3 minutes. Again ground self before inserting hydrometer or thermometer into the cell. The

wearing of rubber- or composition-soled shoes should be avoided in battery rooms where static is a problem. (See 1.09.)

1.09 Electrolyte is corrosive when in contact with most metals and vegetable or animal products including wood, clothing, and most floor coverings, but excluding rubber and lead. Electrolyte acts more quickly on cotton, rayon, and nylon than on wool, orlon, dacron, and dymel but cotton is much safer than the other fabrics as regards freedom from the generation of static electricity. Cotton is therefore the preferred clothing material for battery room wear. When moving hydrometer, be sure electrolyte is not thrown by the rubber tip catching on the cell or the hydrometer holder. A coating of petrolatum on the hands will give some protection in the case of slight exposure to electrolyte, but such coating should not be used when working on plastic or ceramic parts. Electrolyte in contact with materials subject to corrosion should be neutralized promptly.

1.10 The preferred neutralizing agent is soda solution, except for the eyes where water only should be used, and for clothing where approximately one part of household ammonia to two parts of water may be used to avoid the white spots left by soda. Use caution when opening ammonia bottles since considerable pressure sometimes builds up in the bottle, and ammonia or concentrated vapor is dangerous if gotten in the eyes or nose. Ammonia fumes may also adversely affect the commutation of nearby rotating machines. Soda solution should be wiped off painted or varnished surfaces and in no case should it or ammonia be allowed to enter the cells.

1.11 A strong soda solution is 2 pounds of table soda (bicarbonate), 1 pound of washing soda, or 1/2 pound of Bell System pyrophosphate cleaner to 1 gallon of water. It is of use where there is large concentration of electrolyte as in the case of spillage or dripping. A gallon of strong soda solution will neutralize 1/2 to 1 pint of 1.210 electrolyte.

Note: Pyrophosphate cleaner is usually available in building service supplies. It does not bubble as does soda when in contact with electrolyte.

1.12 A weak soda solution is approximately 4 ounces of table soda (bicarbonate), or 2 ounces of Bell System pyrophosphate cleaner per gallon of water. It is of use in neutralizing traces of electrolyte.

1.13 The grids of KS-5553-01, KS-15544, and KS-15754 cells are made of lead-calcium instead of the lead-antimony used in other cells. Unless otherwise specified, all requirements and recommended procedures in A or B series practices for lead-antimony cells shall also apply to lead-calcium cells.

KS-5553-01 covered experimental cells used principally on early TD-2 stations. No more will be furnished. KS-15754 covers small cells used in P carrier pole-mounted units.

1.14 Whenever water or electrolyte samples are sent to the battery manufacturer for analysis, a letter should be written to the manufacturer giving full details, including information necessary for identifying the shipment. These samples are discussed in 3.03(3), 3.08(6), 3.08(7), and 3.19(9). In the case of Exide, samples should be sent to the factory only after discussion with the local Exide representative, and a copy of the shipping letter should be sent to the local representative.

1.15 Where cell containers are not transparent or where transparent containers are mounted in pans, cases, or trays, it is obvious that certain of the instructions, particularly where "gauge by eye" is specified, cannot be followed.

1.16 Strings of the same number of lead-acid cells with the same nominal specific gravity may be operated in parallel whether or not the strings are of the same manufacturer, of the same size, of the same type, of the same age, or have the same internal construction. For satisfactory operation, all cells of the same string must be from the same manufacturer, must be of the same capacity rating, must have plates of the same material, that is, all lead-antimony or all lead-calcium, and must have the same nominal specific gravity. At present all KS-coded cells have low specific gravity except those per KS-15754 which have high specific gravity. (See 1.01.) It is desirable but not always possible that all cells of the same string be of the same age within a year or so, that they have the same type of separators, that is, all rubber or all wood, and that they have plates of the same thickness.

1.17 All readings of a particular set should be taken by the same attendant and with the same instruments.

#1.18 Requirements and associated procedures marked with a number sign (#) need not be checked by the installer unless it is thought that the requirement is not being met or performance indicates that such a check is advisable.

\*1.19 Requirements marked with an asterisk (\*) need not be checked during maintenance unless the apparatus or part is made accessible for other reasons, or performance indicates that such a check is advisable.

1.20 For the purpose of this section, large cells are those whose 8-hour rated capacity is over 100 ampere-hours, and small cells are those of 100-ampere-hour ratings and smaller.

1.21 For the purpose of this section, a string is all the cells permanently connected in series without taps. Each cell in a string is subject to the same current conditions, that is, has the same charge or discharge current.

1.22 For the purpose of this section, floated is 24-hour continuous float per Section A301.005, lightly worked is a maximum of 2 cycles per 24-hour day with a 10 per cent maximum discharge per cycle, while worked applies to any battery that is neither lightly worked nor floated. An exception is that float for KS-15754 cells is per Section A301.865.

1.23 For the purpose of this section, anticipated life shall be considered the number of years listed in the following table for the particular type of cells and routine under consideration. Dates mentioned and start of intervals are based on initial charge.

Type of Cell	Anticipated Life - Years		
	Floated	Lightly Worked	Worked
KS-5553-01	15	-	-
KS-15544	25	-	-
KS-5553, KS-5562	14	7	5
KS-5378, KS-5520	14	7	5
KS-5361, L120 to L151A, KS-5538, L2, L4 to L15	8	7	5
KS-5361, L100 to L116C, KS-5538, L1, L3, L16 to L18, KS-5269-01, 5-2B-15	5	4	3
KS-15577 (over 150 A-H)	8	4	-
KS-15754	15	10	-

Note: In case of claims based on failure to meet these anticipated values, it should be realized that we have some unfavorable operating conditions where actual life may fall materially short of these values. Examples of this are batteries in auxiliary repeater or carrier stations where ventilation has been inadequate and cells are on 3-tier racks. Excess temperatures, wide temperature variations between cells, and failure to maintain specified float voltage are the usual causes of short battery life. Float voltmeters must be kept in accurate calibration, and control equipment in proper adjustment. In case of complaints, conclusions satisfactory to all are less likely where battery records are incomplete.

2. REQUIREMENTS

\*2.01 Initial Charge Voltage: At the end of the initial charge and at charge voltage, no cell corrected voltage shall be more than 0.10 volt above or more than 0.06 volt below the string average, that is, the sum of individual-cell readings divided by the number of cells.

Use voltmeter and battery thermometer.

\*2.02 Turnover Voltage: Within a week of turnover and at least 3 days after the end of the initial charge of cells that are to be floated, no cell corrected voltage on float shall be more than 0.10 volt above or more than 0.04 volt below the string average. There is no turnover voltage requirement on cells not to be floated.

Use voltmeter and battery thermometer.

#2.03 Cell voltages during life shall be as called for in the associated operating section.

Note: Individual-cell voltage variations are objectionable only as they may indicate irregularities. After installation, unless required locally, readings to check individual-cell voltages need be taken only if called for in the associated operating instruction or if it is thought that the cell is not in proper condition. Voltage readings need be corrected for temperature only if cell temperature variations exceed 2 degrees Fahrenheit.

2.04 The temperature of the electrolyte in any cell shall not exceed 110F, except during the last 3 hours of an initial charge. Appreciably lower operating temperatures, 65F through 75F, are preferable.

Use cell thermometer.

2.05 Individual cell temperature variations in any one string should not exceed 5 degrees Fahrenheit.

It is not always possible to meet this important condition.

Use cell thermometer.

2.06 Freezing temperatures shall not be permitted at batteries.

Note: Fully charged low gravity batteries on float, on open circuit for 90 days or less when new, or 60 days or less after first half of anticipated life, or on discharge for 16 hours or less at not more than 5 per cent of the 8-hour rate, will probably be safe down to -15F ambient (that is, temperature of air near the cells). High gravity cells under the same conditions will probably be safe down to -50F. Note, however, that the capacity at 0°F will be less than half that at 77F, and on heavy discharge, the voltage may

be down as much as 0.2 volt per cell. Additional information is available in Section A801.002.

\*2.07 Level of Electrolyte During Installation Period: Cells (see 1.06) with any type of antiexplosion feature shall have water added before the initial charge, if necessary, to bring the level up to minimum but no higher. Electrolyte need not be removed, however, to reduce this level unless the cells had had electrolyte or water added previously by the installer. On other cells, it is only necessary that the top of the plates be covered at start of charge. Toward end of initial charge the level of all cells shall be raised to the maximum level. (See Table A and note under 2.08.)

#2.08 Level of Electrolyte During Life: After the initial charge, water shall be added as necessary to maintain the level between the maximum and minimum. During charge, the electrolyte may rise above the maximum. If filling is necessary with electrolyte below 50F, fill only to 1/4 inch (gauge by eye) below maximum. Adding larger amounts at longer intervals is preferred to adding small amounts frequently. (See Table A.)

Note: Levels below the top of the plates permit the plates to deteriorate. Levels below specified minimum may nullify anti-explosion features. Filling above the specified maximum particularly at lower temperatures may cause overflow on charge.

Caution: The addition of acid or electrolyte to any cell as a substitute for adequate charging is a very serious form of battery abuse.

\*2.09 Specific gravity at turnover of low gravity cells shall be between 1.225 and 1.195 when electrolyte is at maximum level or not more than 1/4 inch below maximum. →Specific gravity at turnover of high gravity →cells shall be 1.285 to 1.315. An exception is that on cells with charge indicators, the specific gravity at turnover shall be sufficient to float all indicator balls.

#2.10 Specific gravity during life of low gravity cells shall be 1.180 to 1.225 →and of high gravity cells (KS-15754) shall →be 1.275 to 1.315. Unless called for in the operating section or required locally, individual-cell specific gravity readings need be taken only when pilot-cell specific gravity does not meet requirements or when the appearance, voltage, etc., of a certain cell or cells raises doubt as to their condition.

2.11 Specific Gravity Variations: When new cells are installed, or specific gravity of electrolyte is adjusted, the corrected specific gravity variation between cells of the same string, when their levels are approximately the same, shall not exceed 10 points (0.010) for large cells and shall not exceed 15 points (0.015) for small cells. (See 2.12, note B.)

Table A - Electrolyte Level

	<u>Maximum</u>	<u>Minimum</u>
KS-5553 and KS-15544 in transparent containers, KS-5361, L116 to L151A, KS-5538, → KS-5378, KS-5520, KS-15754, and 5-2B-15	High line top	Low line top
KS-5553, KS-5553-01, KS-15544, and KS-5562 in nontransparent containers and with no float covers	Second color visible	Top of float just shows
KS-5553 and KS-5562 with float covers	High line bottom	Low line top
KS-5361, L100 to L115C, KS-5269-01, and KS-15577	Bottom of cover	Top of separators

Note: Maximum and minimum level of cells with transparent covers over floats are attained when the leading edge of the float target reaches the above maximum and minimum lines marked on covers. On some small cells where plant design does not permit observing level lines on part of the cells, use top of separators and bottom of cover as limits.

#2.12 Specific gravity after adjustment upwards for low gravity cells past three-fourths of their anticipated life shall be 1.200.

Note A: All electrolyte specific gravity requirements listed herein are for a fully charged cell at the office reference temperature, which may be either 70F or 77F. Correction scales on thermometers now being supplied are arranged for correction to 77F, and reference temperature in offices equipped with these thermometers will be 77F. Offices still having thermometers with scales for correction to 70F will continue to use 70F as the reference temperature. This will result in 2 points' difference in recorded specific gravities when corrected to these two different values but the same tables and instructions shall be followed for either reference temperature. If the reference temperature is changed from 70F to 77F during the life of the battery, the date of change should be prominently indicated in the office records so that the 2-point shift in recorded specific gravities will not be misinterpreted.

Note B: With cells of modern construction on operating routines that produce little gassing, the electrolyte obtained from the top of the cells, when taking hydrometer readings after charging or after adding water, is likely to be low in specific gravity even with fully charged cells having electrolyte of the correct specific gravity at the plates. Some mixing of the electrolyte can be accomplished with the hydrometer, but accurate final readings will be obtained only after long enough time for diffusion to equalize the specific gravity in different parts of the cell. Where apparent specific gravities are out of limits after a charge or after the addition of water, defer for 6 weeks on lead-calcium cells, and 2 weeks on lead-antimony cells, the corrective ac-

tion per 3.10(5). During discharge, on the other hand, the heavier electrolyte at the top of the cell promotes rapid mixing, and hydrometer readings will more quickly follow the state of charge of the battery.

\*#2.13 Capacity: The capacity of cells shall be sufficient to provide the reserve required at the office.

Note: Reserve for a particular office is the hours to be expected at office load in amperes to the end voltage for the office. Average curves at 77F for fully charged new batteries to 1.75 volts per cell, the usual end voltage, are shown on attached Power Data Section 5.15, Sheet 2. Curves to other less frequently used end voltages are on file in the telephone company engineering department.

2.14 Battery connections shall be tight and free from dirt and corrosion.

Test with insulated wrench.

Note: Where a wax dipped solderless terminal lug connects a lead to a battery post, the connection of the lug to the post should be checked, but the connection to the wire should not be checked unless breaks in the dipping material or other indications suggest that the connection may have loosened.

2.15 Electrolyte on or around the posts shall not be permitted to remain on the terminal posts, terminal connections, and straps or on the cover around the posts.

2.16 Containers shall be free from cracks, leaks, spraying, or creepage of electrolyte.

2.17 Covers shall be clean, free from electrolyte, and in good condition. Seals, if any, between covers and containers shall

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be intact. The seal may be considered as intact unless there are definite signs of electrolyte creepage between the container and the cover.

Note: 2.18 through 2.21 can be checked for only in cells in transparent containers or in open tanks.

2.18 The tops of the battery plates shall be free from excessive moss.

2.19 The plates shall not have excessive sulfate.

2.20 Sediment shall not touch the bottom of the separators or plates.

2.21 Plates shall not be badly buckled, cracked, or broken. Minute cracks or holes caused by the cracking out of small pellets of active material are to be expected and require no correction.

Miscellaneous Battery Equipment

2.22 Battery racks, stands, cabinets, casings, bus bars, and any miscellaneous battery equipment shall be clean and free from corrosion.

2.23 Ceramic parts, such as the explosion-proof domes on some cells, as well as the rings on explosion-proof vents, shall be intact; that is, they shall be neither cracked nor broken. The ceramic rings on explosion-proof vents of small cells shall be washed at installation to remove acid. During life, they shall not be excessively wet with electrolyte. Ceramic domes should be washed only if they are so dirty as to offer danger of cell overflow due to clogging of the pores.

2.24 Level indicator floats shall be free to move as electrolyte level changes. Paint on float stems shall be free from chips.

2.25 Filling funnels of lead-antimony alloy shall not be used or installed in cells with lead-calcium plates. (See 1.13 and nameplate on the cells.) Thermometers, hydrometers, and plastic funnels may be used interchangeably in either lead-antimony or lead-calcium cells.

Drainage, Ventilation, and Battery Room Condition

2.26 Arrangements for ventilating and draining battery rooms, cabinets, or casings shall be in operating condition.

2.27 Floors, walls, ceilings, doors, window frames, window casings, radiators, piping, etc., shall be properly painted or otherwise protected.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, and Materials  
(Equivalents May Be Substituted)

Tools

Brush, small paint (obtain locally)

Brush, typewriter, R-2969

Copper, soldering, pyramid point, 1 or 2 lb

→Cord, test, WIAF

Filler, cell, syringe type KS-5499, L1401 for KS-5361, L100 to L115

Flashlight, regular or angle

Goggles, coverall

Knife, putty, R-1060

Picks and cords, test, Weston D-79650 and D-79651

→Receiver, No. 716A

Screwdriver, cabinet, 3 inch

Stick, orange, KS-6320

Tube, rubber (obtain locally for use as siphon on larger cells when bulb equipped siphon is not available)

Wrench, adjustable or open end, as required for bolt connectors. If special wrench is required, it will be furnished with the connectors. Wrenches should be insulated with tape or tubing, either plastic or rubber. A double-ended wrench is acceptable only if the entire unused end is thoroughly insulated.

Gauges

Hydrometer, syringe type, KS-5499, List 1301 or KS-5499, List 1303

As furnished with the cells

Scale, steel, 6 inch, R-8550

Thermometer, Eimer & Amend No. 32155, 0°F to 220°F or Line, -20°F to 130°F

Thermometer, nonfloating, KS-5499, List 1351, 10 inch or KS-5499, List 1352, 6-1/2 inches  
As furnished with the cells

Voltmeter, dc, Weston Model 931, range 0-3

Voltmeter, dc, Weston Model 931, range 300/150/75/30

Materials

Ammonia, household

Apron, rubber R-3043

or

→Apron, plastic, style 2072-D, M. L. Snyder and  
→Son

Brush, wire (obtain locally)

Cloth, cleaning, KS-14666

Compound, battery sealing, battery manufacturer's type

Compound, Silicone R-3126 D.C. No. 4 (2-ounce tubes)

Container, glass, glazed porcelain, plastic, rubber, earthenware, or lead for handling electrolyte or water.

Electrolyte, sp gr not to exceed 1.300 at 60F, battery manufacturer's type

Funnel, glass or plastic (obtain locally)

Gloves, Goodrich 2921 size 10, R-3034, for installation and heavy duty

Gloves, Neoprene, Charleston Rubber Co., N140-R (size 9) or N141-R (size 10), for lighter work

Sandpaper 4/0, commercial

Soda, table (bicarbonate)

Water, distilled or approved for use in storage cells

Wax, black, Johnson's No. W-5016 (from Exide or C&D) 1 pint or 1 quart

### 3.01 Initial Charge Voltage (Rq 2.01)

(1) In general, end of initial charge and turnover voltages as well as voltage values quoted in complaints should be corrected for temperature [see (2)] because neither the installer nor the battery manufacturer is responsible for temperature extremes or irregularities in the particular office. Also voltage readings taken at different times and then compared should be corrected for temperature to be sure apparent irregularities are not due to temperature differences. Operating voltages on the other hand, such as specified average float voltage and minimum allowable cell voltage on float, are uncorrected since they are intended to apply at the temperature actually present in the office. Voltage values in charging tables assume the use of uncorrected voltages.

(2) To correct voltage reading for temperature, add 0.01 volt for each 3F the electrolyte of any cell is higher in temperature than the lowest temperature cell. String temperature variations of 2F or less may be disregarded.

\*(3) If cell voltages are out of line at the end of the initial charge, repeat the initial charge. The second charge may be discontinued at any time that the voltages are found to be within limits. Cells out of limits after two full initial charges are unsatisfactory.

### \*3.02 Turnover Voltage (Rq 2.02)

(1) If cell corrected voltages are out of line on float just before turnover, give a boost charge in accordance with installing Section A301.009 or operating Section A301.005. [See 3.01(2).] If cells are still out of line three days after this charge, they are unsatisfactory.

### #3.03 Cell Voltages During Life (Rq 2.03)

(1) During life, a steady drop in cell corrected voltage would be an indication of irregularity, if not actual trouble. Cells with dropping voltage should be watched for sulfation or other signs of trouble. [See 3.01(2) and operating section.]

(2) Where during life the corrected voltage of one or more large cells in a battery is steadily decreasing, the supervisor may be justified in approving reduction of specific gravity of electrolyte and special charging as outlined under sulfation.

(3) If it is thought that the decreasing voltage may be due to electrolyte contaminated by outside matter, particularly iron, the supervisor may wish to replace the electrolyte, or in case of doubt on large cells, send a sample (see 1.13) to the factory of the battery manufacturer for analysis. This sample should be in a 1-pint glass container with rubber stopper and sent by express. A 4-inch white acid label on outside of package is required by the express company.

### 3.04 Temperature of Electrolyte (Rq 2.04)

(1) The thermometer should be in the electrolyte for at least 2 minutes before reading the temperature. When the thermometer is equipped with a rubber collar of such size as to permit positioning of the thermometer, the collar should be set so that the thermometer bulb is completely immersed in electrolyte. Where there is no collar or the collar is too small to be stopped by the top of the cell or funnel, the thermometer may be inserted until stopped by the top of the plates or separators. On some large plastic cells the relative size of the vent opening and the rubber collar on some thermometers is such as to result in stopping the escape of gas. Where this is true and the cell has only one vent, the rubber collar should be discarded.

(2) If the temperature rises above the specified limit, discontinue the charging, or lower the charging rate until the temperature is reduced to 95F or less.

### 3.05 Temperature Variations (Rq 2.05)

(1) In some cases, shields between cells and nearby radiators and blinds to block direct sunlight will prevent excess differences in cell or ambient temperatures. The

top and bottom rows of 3-tier racks are particularly apt to have widely different temperatures. Where this condition exists, additional fans or other ventilating equipment is recommended.

(2) Where local conditions make it impossible to meet requirements after improving the ventilation by opening windows, etc., notify the supervisor, and if possible, keep the electrolyte temperature from exceeding the ambient temperature by more than 10 degrees Fahrenheit.

### 3.06 Freezing Temperatures (Rq 2.06)

(1) Where there is danger of freezing under either normal or power failure conditions, notify the supervisor, who may wish to consider special enclosures, insulation, or heaters.

### \*3.07 Level of Electrolyte During Installation Period (Rq 2.07)

(1) Special methods for maintaining proper level before turnover are covered in installing Section A301.009.

### #3.08 Level of Electrolyte During Life (Rq 2.08)

(1) Distilled water or water approved for storage battery use should be used to bring up electrolyte level. Tap water, when approved, should be allowed to run for a while before filling cells to avoid the iron rust or sediment from the local piping getting into the cells. The containers approved for electrolyte are satisfactory for handling of water for batteries. The best time to add water is toward the end of a charge.

(2) There have been a few cases of cells overflowing during charge. Be very careful not to fill above the maximum and check that float covers, if any, are properly seated. Check floats, particularly those with no float covers, with the fingers to be sure they are not sticking. Broken or saturated floats will give a false indication of level, resulting in overflowing. If possible, schedules should be arranged so that filling will be when electrolyte and water temperatures are above 50F since overflow is possible if cells are filled to maximum level at low temperatures. If overflowing persists, refer to supervisor who may wish to authorize a special filling procedure, such as (a) filling only to the midpoint between maximum and minimum or (b) delaying cell filling until charge is half or more completed and cells are gassing. Be sure overflowing is not due to filling above allowed maximum.

(3) Where plant design does not permit observing level lines on all cells, usually those in the rear row or cells in crates, the electrolyte level can usually be ob-

served through the vent or fill hole and maintained per note under Table A. Where low headroom or other lack of space prevents such observation, the use of a pipette such as a 1/8-inch glass or plastic tube is suggested. The tube is inserted until stopped by the plates or separators. The top of the tube is then closed with the finger so that, when tube is raised, the level of the electrolyte can be seen at a glance. If desired, the tube can be marked on the job to show maximum and minimum levels based on checks of a more accessible cell. The tube should be obtained locally. It should be long enough to reach from the top of the separators or other stop to an inch or two above the cell as convenient.

(4) With enclosed-type batteries, spilling electrolyte on the cover should be avoided, but any so spilled should be wiped off with a cloth moistened in a weak soda solution. If water is spilled on the cover, wipe off with either dry or moistened cloth. Where cells have a vent in addition to a filling tube, water should be added only through the filling tube. After filling, if there is a filling tube extending down into the electrolyte, and there is any possibility of ambient temperature falling below 32F, agitate the electrolyte in and near the filling tube with air from the hydrometer to cause mixing and avoid freezing in the tube.

(5) If a hose is used to add water, there should be a cutoff valve on the hose at a convenient point for control by the man at the cell. A cell filler syringe is sometimes provided for use with small cells where access is limited.

(6) In case of doubt that the local water is approved for battery use, a 1-quart sample may be sent to the battery manufacturer (see 1.13) for analysis. This action should be taken only when specified by the supervisor. If the water available at more than one office comes from the same water supply, samples from only one office are sufficient and need be sent to only one of the battery suppliers. The label sent with the sample should give the following data:

Name of telephone company, city, and state.

Type of cells installed; that is, open, enclosed, or both.

Operating method; that is, continuous float, cycle operation with 10 per cent daily discharge, etc.

Source of water supply; that is, city water from reservoirs fed by streams or from wells, local well, or cistern water, etc.

(7) When water analysis is authorized, the first samples from any water supply area should be sent in, once in the wet spring

season and once in the dry autumn season, since there is sometimes an appreciable difference in the amount of impurities under these different conditions. If these two tests prove satisfactory, the water can be used, but it is desirable that it be rechecked about every five years, one sample at any season usually being sufficient. If either the spring or autumn sample is satisfactory and the other unsatisfactory, it may be dangerous to use the water, but additional samples may be sent in the following spring and autumn to see if the unsatisfactory condition was temporary. In the meantime, a study of the water supply may help to determine whether the water is likely to remain either satisfactory or unsatisfactory. If chlorine is the cause of rejection, the practice of the health authorities may be investigated. The amount of fluorides usually added to drinking water for health reasons will not adversely affect the water for battery use. Where both samples are unsatisfactory, but there is information that conditions may have changed, a sample may be sent in, say every other spring, to be followed by one in the autumn, if the spring sample proves satisfactory. In applying the above suggestions, any changes in the water source should be taken into consideration and periods between samples shortened until it is known that the changed water is safe.

### \*3.09 Specific Gravity at Turnover (Rq 2.09)

- (1) Where small adjustments of electrolyte are necessary during the installation period, it is sometimes more convenient to trade small amounts of electrolyte between the high and low cells using the syringe-type hydrometer to make the transfer.
- (2) If larger adjustment is necessary, drain off the correct amount of electrolyte and replace it immediately with electrolyte of specific gravity not to exceed 1.300 to adjust upward or of approved water to adjust downward and give the cell a mixing charge of 1 hour at the nominal rate, 2 hours at 1/2 nominal rate or 4 hours at 1/4 nominal rate. Battery must be in a fully charged condition at the time of adding the higher specific gravity electrolyte and starting the mixing charge.

#### (a) Sample Calculation to Determine Amount of Electrolyte to be Removed:

Assume that the specific gravity at 77F and at full charge is 1.174, and that due to the age of the cell, the upper limit to which it may be adjusted is 1.200. (See 2.12.) To obtain approximately 1.198, an increase of 24 points (0.024) is required. The specific gravity of 1.294 (1.300 at 60F) electrolyte is 120 points (0.120) higher than the specific gravity of the electrolyte in the cell. The proportion to be replaced by 1.294 electrolyte is then  $\frac{0.024}{0.120} = 20$  per cent. If about 1/5 of

the electrolyte in the cell (see Tables B to D) is replaced by 1.294 electrolyte, the resulting solution after the mixing charge should be approximately as follows:

$$(0.20 \times 1.294) + (0.80 \times 1.174) = 1.198.$$

**Note:** The electrolyte-per-cell values in Tables B to D are average for cells of different manufacturers, and in some cases, for cells of different dates from the same manufacturer. From past experience, they seem to be sufficiently accurate for usual adjustments, in view of the wide limits permissible for the resulting specific gravities. Where large adjustments are to be made on several cells, and final values must meet narrow limits, it is suggested that electrolyte per cell for the particular cells be checked with the battery manufacturer before starting the adjustment. This condition does not usually exist during the installation period.

- (3) To remove electrolyte from cell, smaller cells may be turned on their side while larger cells may be emptied with pump or siphon, if available. With the usual type of commercial siphon having a starting bulb, one end of tube is placed in electrolyte, the bulb is depressed, the open end of tube is closed, the bulb is released, the open end is again opened, the bulb depressed, the open end is closed, and this action is repeated until electrolyte flows from open end, which must be below the level of the electrolyte. If flexible-rubber tube without starting bulb is used, start siphon by filling the tube with water and pinching one end while the other is being lowered into cell. When released, the pinched end should, of course, be below the level of the electrolyte. The replacing water or electrolyte should be at hand before electrolyte removal so that the cells may be capacity due to oxidation of the negative plates.

- #3.10 Specific Gravity During Life (Rq 2.10)
- 3.11 Specific Gravity Variations (Rq 2.11)
- #3.12 Specific Gravity After Adjustment Upward (Rq 2.12)

### Taking Hydrometer Readings

- (1) Electrolyte temperature readings are always taken at the same time as hydrometer readings and in the same cell, or if this is difficult, in an adjacent cell to permit correction of readings for temperature as described below. See precautions in Part 1, General, against explosions and damage from acid. Whenever hydrometer readings are taken, record also the distance in quarters of an inch from level of electrolyte to minimum or maximum level in order that irregularities caused by readings at different levels may be discounted.

(2) Where syringe-type hydrometer is used, insert it into the electrolyte through the opening used for adding water. Hydrometers and thermometers are not to be inserted in the vent of cells with explosion-proof covers, except for some jars with plastic covers, where the vent is the only opening and must be used for water additions.

(3) Draw electrolyte into the barrel of a syringe-type hydrometer first, until float just hits the top. This is to wet the float. Then repeat until the float clears the bottom of the barrel and does not hit the top. Hold barrel in vertical position, and be sure float is free to move. Take reading at level of electrolyte on the float scale. If the cell is gassing appreciably, rotate the barrel gently for several seconds after filling, but before taking readings. This is to permit gas to escape but prevent float from sticking to the barrel. If hydrometer is presumably at room temperature, and the electrolyte is more than 20 degrees warmer, warm the hydrometer before readings by filling and emptying it three or four times. On cells of later types where the filling tube extends down into the electrolyte, promote mixing by filling and slowly emptying the hydrometer three or four times before taking readings. Avoid dripping or throwing of electrolyte from the hydrometer tube. Frequently washing hydrometer barrel and float with soap and water reduces chance of sticking and improves readability.

#### Correcting Hydrometer Readings for Temperature

(4) Hydrometer readings should be corrected for temperature so that readings taken at different times will be comparable. The corrected specific gravity is practically what the hydrometer would have read if the electrolyte temperature were at office reference temperature. This has been discussed in note A under 2.12. The number of points to be added or subtracted from the hydrometer reading may be read directly from the battery thermometer. On older large barrel thermometers, the correction is given in three digits, for example, 2 points of plus correction is given as +0.002. On newer slim barrel thermometers, the same two points correction (+0.002) is given as +2. It may also be calculated, in which case, one point (0.001) should be added for each 3 degrees which the actual electrolyte temperature is above the office reference temperature, or one point should be subtracted for each 3 degrees which the actual electrolyte temperature is below the office reference temperature.

#### Specific Gravity Adjustment

(5) If the corrected specific gravity of the electrolyte in any cell of a fully charged battery is outside the prescribed limits,

check to be sure other requirements are being met, and if specific gravity is still outside the limits, notify supervisor, who may wish to authorize a special charge or specific gravity adjustment. (See 2.12, note B and 3.09.)

#### \*#3.13 Capacity (Rq 2.13)

(1) Battery capacity may start as low as 85 per cent of rated value, increasing during the first year or so to 100 per cent or higher. It should remain during the rest of its useful life near the 100 per cent of capacity expected on floated batteries or the 75 per cent capacity to be expected on cycled batteries. There is probably little useful life left when the capacity at 77F of a floated battery drops below 90 per cent or when capacity at 77F of a cycled battery drops below 75 per cent; and replacement should be considered when such drop is approached. Some estimate of battery capacity and condition may be made as described in operating sections, but the only true measure of capacity is a discharge test of the entire string or of selected cells of the string, preferably the former. A capacity discharge test should be given only when and as directed by the supervisor who should take into consideration office conditions and reliability of commercial power or engine reserve. The battery shall be fully charged before the start of any discharge test.

(2) A check of battery capacity at 77F against rated capacity is at the 8-hour rate to 1.75 volts per cell, but comparable data can be obtained using Power Data Section 5.15, Sheet 2 (page 20), at other rates to 1.75. Where office limits are to some other end voltage, especially if emergency discharges are at high rates, such as the 3-hour rate, an accurate estimate of actual capacity can be made only at the actual discharge rate to the actual end voltage. Discharges at high rates to high end voltages are a very severe service requirement and relatively good batteries for discharge at the 8-hour rate or lower to 1.75 volts may have very little reserve at the high rate to a high end voltage.

(3) A battery discharge test may be at any electrolyte temperature from 50F to 100F. The results should be corrected to 77F by applying a correction constant k from Fig. 1 as described below. From Power Data Section 5.15, Sheet 2 if discharge is to be to 1.75 volts per cell, select a discharge rate which will limit the length of discharge to an acceptable time and discharge at this rate to 1.75 volts per cell, noting the time required for the discharge. The actual capacity at 77F in per cent of rated value is the actual length of the discharge divided by the expected length of discharge from the data sheet, multiplied by temperature correction constant k for the

electrolyte temperature at start of the discharge. The actual capacity at 77F in ampere-hours is the rated capacity multiplied by actual length of discharge, divided by the expected length of discharge, multiplied by temperature constant k, divided by 100.

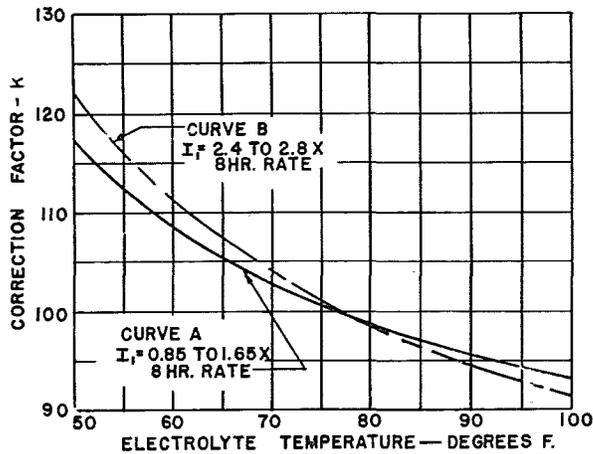


Fig. 1 - Correction of Capacity for Temperature

**Example:** Assume a KS-15544, L402 battery (240 AH) discharged at 40 amperes to 1.75 volts per cell in 4-1/2 hours at 60F temperature. From the power data sheet, the expected length of discharge at 77F at this rate is 5-1/2 hours. From Fig. 1, k is 108.5.

Capacity in per cent of rating is:

$$\frac{4.5}{5.5} \times 108.5 = 88.8 \text{ per cent}$$

Capacity in ampere-hours is:

$$240 \times \frac{4.5}{5.5} \times \frac{108.5}{100} = 213 \text{ AH}$$

$$\text{or } 240 \times 0.888 = 213 \text{ AH}$$

(4) Note that correction factor k is used so that test results can be compared with rated capacities at 77F. On a check to see if actual capacity is sufficient to provide necessary reserve at some other temperature, see temperature capacity table in Section A801.002.

(5) Where the battery consists of two strings or more in parallel, and it is practical to do so, one string at a time may be disconnected from the working battery and discharged, using artificial load per Section A801.910 or other load locally available. When reconnecting strings, they should be at as near the same voltage as possible to avoid sparks or arcs and danger of battery explosions.

(6) Another method is based on using the office load supplemented, if necessary, by an artificial load to discharge one string while the other string or strings are held in reserve. An attendant should be available at all times to reconnect the reserve strings in case a commercial power failure occurs during this test and care should be taken to avoid explosions due to the arcs to be expected when connecting together strings at different voltages. A temporary jumper to a switch some distance from the battery is recommended. The office characteristics and normal load curve should be studied in advance to be sure that office load current, supplemented if necessary by artificial load during the test, will be greater at all times than the discharge current selected for the test. The drain on the test string should then be held to the selected value, as the office load varies, by manual control of the charging equipment. Except in emergencies, the discharge should be continued at the selected rate to the end voltage, usually 1.75 volts per cell, and capacity calculated. [See (3) above.]

(7) Where the battery consists of a single string, a spot check of a few cells, one or two at a time, may be made without changing control equipment or interfering with service, provided battery finishing rate is not exceeded on recharge. The lowest voltage cell, the highest temperature cell, and the cell with the lowest corrected specific gravity should be included in such a spot check.

(8) Sections A201.033 and A201.034 cover a series of single cell discharge tests for cells up to 1680-ampere-hour capacity. It is entirely possible to extend Section A201.034 to larger cells by using sufficient load units in parallel or other load as available, but the enormous current required on discharge and the large current or long time required on recharge make the cost and inconvenience of this type of charge for larger cells unattractive. The reason for the high discharge current is to get conclusive results at the test rate while there is still appreciable capacity on an 8-hour rate basis remaining in the cell at the end of the test.

(9) One method of providing part of the load for a spot check of cells in a single string working battery is to discharge an entire string on office load [see (6)] at a fixed rate not to exceed the 8-hour rate while at the same time discharging a single cell [see (8)]. The test load for the test cell can then be reduced by the amount of the load on the string.

**Example:** If test is to be at 2.6 times the 8-hour rate and the 8-hour rate can be taken from the string, then only an additional 1.6 times the 8-hour rate need be taken from the individual cell. Since the test per Section A201.034 takes

about 2 hours, only a quarter of the rated capacity will be taken from the cells not being tested and slightly more than half of the rated 8-hour capacity from the cell being tested. When this method is used, not only the test cells but also the string must be recharged before extending the test to other cells in the same string.

After any test discharge of a cell or a string, the recharge should be at 110 per cent of the discharge in ampere-hours even though slightly less may be sufficient for lead-calcium cells.

### 3.14 Battery Connections (Rq 2.14)

(1) Since lead is a soft metal subject to cold flow, lead to lead or lead to other metal connections require periodic tightening. If a connection is corroded or damaged, open up the connection, taking precautions that service will not be interfered with and that there will not be an arc causing an explosion. Scrape off all corrosion, being careful not to remove enough lead to expose the copper, neutralize with a strong soda solution, rinse, and dry. Scrape or sandpaper to a bright finish, and coat immediately with Silicone Compound. The connection should now be tightened securely. If desired locally, connections may be tested during a period of charge or discharge with a low-resistance receiver with test picks across the connection. A poor connection, either loose or badly corroded, will result in a click in the receiver, provided sufficient current is flowing through the connection.

### →3.15 Posts (Rq 2.15)

(1) Any electrolyte on or around the terminal posts should be wiped up and the area neutralized promptly with strong soda solution. In extreme cases, where creepage around the post is recurrent, notify the supervisor, who may wish to consult the local representative of the battery manufacturer.

(2) The thin coating of lead-oxide that sometimes appears on the positive post and associated connection looks like damp brown stain. This may be evidence of creepage of electrolyte around the post. Free electrolyte should be neutralized with strong soda solution but the neutralizer has no effect on the lead-oxide film. Extreme cases, where the area of creepage is growing more than slightly and contacts are affected, should be called to the attention of the supervisor, who may wish to consult the local representative of the battery manufacturer.

(3) Lead sulfate may appear as white powder around the negative posts. It should be brushed off and the surfaces neutralized.

(4) Green or blue copper sulfate indicates that the electrolyte has gotten through the lead coating of some part and reached the copper. Any such part, other than a post, should be replaced and all associated surfaces neutralized.

(5) Where there are threaded seal nuts that have corroded so badly, usually around the positive post, that the nuts are cracked, the nuts should be removed and the surrounding surfaces cleaned and neutralized. The seal nuts need not be replaced except on cells having cover-supported plates.

(6) Connections on posts with electrolyte creepage should be watched for corrosion and increased contact resistance. [See 3.14(1).] Contacts should be cleaned and neutralized as required. The problem of creepage around the posts is under study. In the meantime, if connections require cleaning no oftener than once a year, maintenance is not considered excessive.

### 3.16 Containers (Rq 2.16)

(1) Replace cells having leaking containers.

(2) Splashed or dripped electrolyte should be wiped up with a dry cloth, followed by a cloth wet with weak soda solution.

#(3) Rubber containers which have become discolored may be refinished on approval of the supervisor. Wash with weak soda solution followed by water. When dry, apply one or more coats, as required, of black wax with a paint brush.

### 3.17 Covers (Rq 2.17)

(1) Covers of enclosed cells should be wiped off with cleaning cloth, dry or moistened in water, or a weak soda solution. Electrolyte on the top of Exide 50- and 100-AH cells with built-in antiexplosion features or KS-15754 cells may be due to absence of spray caps on the top of the funnels.

(2) If there is a blistering or other signs of corrosion of the compound sometimes used around positive posts, scrape or pry out the compound with a small screwdriver. Neutralize with weak soda solution. If corrosion or acid creepage persists, neutralize with a strong soda solution, leaving a small amount of the solution around the post when mopping up the excess solution. Repeat at 2-year intervals until experience suggests another interval. Do not reseal with compound.

#(3) A cover seal of a nonplastic cell can sometimes be restored using a hot soldering copper, but new compound may be required. When resealing is authorized by the supervisor, the old compound, at and near the leak, should be scraped out with a screwdriver or putty knife, after which the affected area should be washed with water

and dried. Battery sealing compound heated to a plastic stage should then be worked into the sealing space thus prepared by using the putty knife, and if necessary, the soldering copper. In emergencies or where a very small amount of sealing compound is required, Western Electric Company's conduit sealing compound may be used, but it is more brittle than the battery compound and is, therefore, less desirable for this application. This procedure does not apply to plastic containers or covers. Plastic covers are not removable.

#(4) During the life of a battery, normal growth of the positive plates may raise or tilt the cell covers and break the cover seal, particularly on cells having positive plates supported from the bottom. An experienced battery man, knowing the cell construction and operating history of the battery, can often make very accurate estimates of the condition of the battery by observing the extent and uniformity of this growth but any rules for such estimates are impractical. Post corrosion can also cause slight raising or tilting of the covers of cells having positive plates supported from either the top or bottom of the containers, instead of from the cover. This is very difficult to distinguish from the effect of normal plate growth mentioned above. Cracking of the cell cover around the positive terminal and raising or bulging of covers in a circle around a post, particularly if this appears on only a few of the cells of a string, are almost always due to post corrosion and should be called to the attention of the supervisor immediately.

### 3.18 Moss (Rq 2.18)

(1) Moss is not prevalent with modern cells on favorable routines, such as float. If more information is required on moss, see Section A401.005.

### 3.19 Sulfate (Rq 2.19)

(1) Report to the supervisor all cases of sulfated plates, even though doubtful. Prompt action may prevent a chronic condition. The best prevention of sulfation is adequate charging in accordance with operating instructions, and accurate instruments and control equipment.

#### Indications of Sulfation and Proof of Normalcy

(2) A decline in the voltage of one or a few cells is often a warning of the start of sulfation, but this should not be confused with the low voltage on a few cells immediately after a charge. Such condition may be due to oxygen from the positive plate temporarily clinging to the surface of the negative plate. This condition will disappear after a month or two on float.

(3) In lead-antimony cells, objectionable (inert) sulfate usually appears first on the outside surface of the outside negative plate in the bus bar lug corner of the plate. The affected area is lighter in color than the rest of the plate and the line of separation between the two areas frequently runs diagonally across the lug corner of the plate.

(4) At floating voltages or less, minute gas bubbles (about size of pinheads) appear on the negative plates. These are usually more numerous opposite the sulfated, than opposite the more normal portions of the plate. The larger bubbles given off by the negative plate and the still larger bubbles given off by the positive plates both near the end of charge at 2.27 volts or higher on lead-antimony cells appear first and are more numerous in normal cells. A cell with little gassing, when the others are gassing heavily, should be suspected of sulfation. When the charging rate is suddenly raised, the cells farthest from full charge are usually the slowest in increasing their volume of gassing, so that cells relatively slow to gas after the voltage has been raised to 2.27 volts per cell on lead-antimony cells would be suspected of sulfation. These indications are not present on lead-calcium cells due to their much higher gassing point and because their float and charging rates are so extremely low under approved operating routines.

(5) Moss is, in general, an indication of excessive charging and a cell having moss continuously from early in its life would not be expected to show sulfation. It should be borne in mind, however, that either a period of excessive charge, after a period of insufficient charge, or a period of insufficient charge after a period of excessive charge might result in moss and sulfate on the same plates, and that moss in sufficient quantities to short-circuit plates will allow the shorted plates to sulfate.

(6) On some types of cells, with the aid of a test light, very small, shiny crystals of sulfate, scarcely recognizable from small trapped gas bubbles, can usually be found scattered over a sulfated negative plate but they also appear on slightly undercharged but unsulfated negatives, so that they are not a very definite indication. On both sulfated and normal plates they usually disappear on charge.

(7) Hydrate spots and crystals of unformed active material are sometimes present on new plates. These confusing signs soon disappear in service.

(8) With No. 301C plants in No. 5 crossbar installations and to a lesser extent in No. 1 crossbar and some other installations, load changes are so great that cell voltages will fluctuate over a relatively wide range. If a few cells in such a string do not fluctuate appreciably, as compared with other

cells in the string, it is an indication that such cells are undercharged and possibly sulfating.

#### Correction for Sulfation

(9) If sulfation is thought to have been caused by contamination of the electrolyte due to material, such as iron, getting into the cell accidentally, the supervisor may wish to send a sample to the battery company for analysis and recommendations. (See 1.13.) If the analysis shows excess contamination, the electrolyte should be replaced by new. On cells too large to handle conveniently, it is suggested that arrangements be made for this work to be done by the battery manufacturer.

(10) The corrective action to take in case of sulfation shall be as directed by the supervisor. Less severe cases of sulfation can sometimes be overcome by a special charge, consisting of a boost charge, followed by sufficient charging to put in two to three times the 8-hour rated capacity of the battery in ampere-hours. More drastic action, consisting of lowering the specific gravity of the electrolyte, may be necessary as described in Section A401.005. Lowering the specific gravity of the electrolyte reduces the capacity of healthy cells, but it restores a part of the lost capacity of subnormal cells by the correction of sulfation.

#### 3.20 Sediment (Rq 2.20)

(1) It is not anticipated that sediment will be a problem with present routines and containers. If for any reason, however, the sediment becomes too high, notify the supervisor, who may wish to authorize leveling of the sediment, removal of all or part of the sediment, or replacement of the cell. After removal of sediment, bring the electrolyte level back to maximum by addition of new electrolyte whose specific gravity is within ten points (0.010) of the specific gravity of the old electrolyte. A cell should be fully charged before any change in electrolyte, and a boost charge should be given after change of electrolyte. With transparent container cells in pans, crates, or trays, lifting of one cell to observe sediment height will give sufficient indication of condition of all cells of same age and general condition.

(2) With enclosed-type cells it is possible, particularly with the smaller cells, to rock the cell to level the sediment.

(3) Electrolyte in enclosed-type cells may be removed as outlined in 3.09 after which the sediment can be washed out with water. Plates should be exposed to the air for as short a time as possible, not to exceed 20 minutes. Where electrolyte has been removed, all except the dregs can usually be re-used.

→ (4) If flood waters overflow a battery, see Section A501.925.

Caution: If flood water is salt water, gas such as chlorine may be given off during rest of life so room ventilation must be adequate.

#### 3.21 Plates (Rq 2.21)

(1) Plates, separators, or containers damaged or otherwise in poor condition should be reported to the supervisor for replacement consideration. Until replaced they should be watched carefully for other signs of trouble. With enclosed-type cells, it will usually be more economical to replace the cell than damaged internal part.

(2) With cells in transparent containers, a flashlight is of assistance in looking for plates that have been broken and dropped down, buckled plates, or separators that have been forced out of position by broken plates.

#### Miscellaneous Battery Equipment

#### 3.22 Battery Racks, Stands, etc. (Rq 2.22)

(1) See that battery rack, cabinet or casing, and battery containers are clean and that the paint on bolts, woodwork, cable, conduit, and copper bus bars is in good condition and not eaten by or exposed unnecessarily to electrolyte. Note that casing or rack is level. All metal work other than lead and aluminum should be properly painted or otherwise protected. Overhead conduit or metal framework should not be allowed to corrode, particular care being taken with such structures over open-type cells, where products of corrosion might drop into the cells.

(2) Clean miscellaneous battery equipment, particularly where exposed to battery fumes, by wiping with a cloth dampened in a weak soda solution.

#### 3.23 Ceramic Parts (Rq 2.23)

(1) Inspect ceramic parts. A crack or break may make them no longer explosion-proof. In no case should they be painted, varnished, or greased. Ceramic rings of explosion-proof vents used on some 50- and 100-ampere-hour cells should be washed at installation. To wash, swish several times through clean water, and then shake out as much water as possible. During life, they should be washed when there is any evidence of their being wetted by electrolyte or the cell has shown any tendency to overflow on charge. Fixed ceramic domes on larger cells are not expected to require washing. If it should become necessary, however, the dome on Gould cells can be removed by turning counter-clockwise. Check that rubber gasket, if any, is in good condition and wet it with water before replacing. Removal of the dome

on some C & D cells requires the use of a hot spatula. It is suggested that the local C & D representative be requested to do this work.

### 3.24 Level Indicator Floats (Rq 2.24)

(1) Occasionally depress level indicator floats with the finger or an orange stick to be sure they are not sticking. Keeping float stems dry will discourage sticking. Failure of float to change position as water is added to the cell indicates that the float is probably sticking, broken, or saturated with water. Replace float if paint is badly chipped or if the float is no longer operating properly.

### 3.25 Filling Funnels (Rq 2.25)

(1) Gould and Exide lead-calcium funnels have a green or blue distinguishing band. Their lead-antimony funnels have no marking. All C & D alloy funnels are of lead-calcium so require no distinguishing band.

### Drainage, Ventilation, and Battery Room Condition

Note: Check of the features described below, if classed locally as building

maintenance, should be made by the employee responsible for maintenance of the battery in order to assure prompt detection of conditions requiring corrective action. When such conditions are noted, the supervisor should refer them to the group responsible for correction.

### 3.26 Ventilating and Draining Battery Room (Rq 2.26)

(1) See that the floor drain, where provided, is free from obstructions, cracks, or leaks. Check drain by pouring water through it.

(2) Check the vent pipe to see that it is free from obstructions and provides a good draft. This can be done by holding a piece of paper or cloth across the end of the vent pipe where it leaves the battery room. Mechanical ventilating equipment, where provided, should function properly.

### 3.27 Floors, Walls, Ceilings, etc. (Rq 2.27)

(1) Check the condition of paint on the floors, walls, ceilings, doors, window frames and casings, radiators, piping, bolt-heads, nuts, etc., to see that these surfaces are properly protected.

## SECTION A401.001

Table B - Small Cell Data

Cells	8-hr Dischg Rates in Amps	Finishing Rate in Amps	Sp Gr Range for Complete Dischg in 8 Hrs	Chg Indicator Nominal Sp Gr			Elect per Cell Gal
				Green	White	Red	
5-2B-15 (C & D)	1.87	1.5	90	1.200	1.180	1.150	
KS-5269-01	1.25	1	70	1.200	1.180	1.165	
KS-5361 Glass Jars							
L100	0.50	0.5	85	1.200	1.180	1.150	0.03
L110 Type - Exide	1.25	1	45	1.200	1.195	1.180	0.18
L110 Type - Gould	1.25	1	100	1.200	1.180	1.145	0.09
L120 Type - Exide	1.875	1.5	72	1.200	1.180	1.150	0.10
L120 Type - Gould	1.875	1.5	90	1.200	1.180	1.145	0.10
L130 Type - Exide	3.75	3	75	1.200	1.180	1.150	0.19
L130 Type - Gould	3.75	3	90	1.200	1.180	1.145	0.19
L140 Type - Exide	6.25	5.25	83		(Note)		0.34
L140 Type - Gould	6.25	5.25	100		(Note)		0.34
L150	12.5	10.5	105		(Note)		0.49
KS-5361 Plastic Jars							
L116 Type - Exide	1.25	1	40	1.200	1.190	1.180	0.16
L116 Type - Gould	1.25	1	55	1.200	1.180	1.150	0.12
L116 Type - C & D	1.25	1	40	1.200	1.195	1.185	0.137
L120 Type - Exide	1.875	1.5	80	1.200	1.180	1.145	0.15
L120 Type - Gould	1.875	1.5	80	1.200	1.180	1.150	0.12
L120 Type - C & D	1.875	1.5	62	1.200	1.190	1.173	0.13
L130 Type - Exide	3.75	3	82	1.200	1.180	1.145	0.21
L130 Type - Gould	3.75	3	80	1.200	1.180	1.150	0.22
L130 Type - C & D	3.75	3	64	1.200	1.190	1.173	0.254
L140 Type - Exide	6.25	5.25	105		(Note)		0.21
L140 Type - Gould	6.25	5.25	85		(Note)		0.30
L140 Type - C & D	6.25	5.25	90		(Note)		0.36
L150 Type - Exide	12.5	10.5	115		(Note)		0.42
L150 Type - Gould	12.5	10.5	95		(Note)		0.54
L150 Type - C & D	12.5	10.5	100		(Note)		0.54
→KS-15754	0.75	0.5	75		1.275		0.055
KS-5538, L1, L3, L16 to L18	See data on KS-5361, List 116						
KS-5538, L2, L4, L5, L6, L8, L10, L12, L14, L15	See data on KS-5361, List 120						
KS-5538, L7, L9, L11, L13	See data on KS-5361, List 130						

Note: KS-5361, Lists 140 to 151A are furnished with charge indicators (nominal sp gr 1.200, 1.180, and 1.145 on Exide and Gould and 1.200, 1.181, and 1.151 on C & D) only when so specified in the order.

Table C - Cell Data

Cells	8-hr Dischg Rate in Amps	Finishing Rate in Amps	Sp Gr Range for Complete Dischg in 8 Hrs	Chg Indicator Nominal Sp Gr		Elect per Cell Gals
				White	Red	
KS-5378,L430	10	10	34	1.195	1.185	1.75
KS-5378,L431	15	15	60	1.185	1.165	1.75
KS-5378,L432	20	20	65	1.185	1.160	1.75
KS-5378,L433	25	25	67	1.185	1.160	2.00
KS-5378,L434	30	30	70	1.180	1.160	2.25
KS-5378,L435	35	35	72	1.180	1.160	2.50
KS-5378,L436	40	40	73	1.180	1.155	2.75
KS-5378,L437	45	45	75	1.180	1.155	2.75
KS-5378,L438	50	50	76	1.180	1.155	3.00
KS-5378,L439	55	55	76	1.180	1.155	3.25
KS-5378,L440	60	60	77	1.180	1.155	3.50
KS-5378,L441	65	65	77	1.180	1.155	3.75
KS-5378,L450	13	13	42	1.195	1.180	5.50
KS-5378,L451	19.5	19.5	56	1.190	1.170	6.50
KS-5378,L452	26	26	50	1.190	1.175	8.25
KS-5378,L453	32.5	32.5	59	1.190	1.170	9.75
KS-5378,L454	39	39	66	1.185	1.160	10.75
KS-5378,L455	45.5	45.5	60	1.190	1.170	12.50
KS-5378,L456	52	52	65	1.185	1.160	13.75
KS-5378,L460	13	12	42	1.195	1.180	1.50
KS-5378,L461	19.75	18	56	1.190	1.170	1.50
KS-5378,L462	26.25	24	50	1.190	1.175	2.25
KS-5378,L463	32.5	30	59	1.190	1.170	2.50
KS-5378,L464	39.5	36	66	1.185	1.160	2.75
KS-5378,L465	46	42	60	1.190	1.170	3.50
KS-5378,L466	52	48	65	1.185	1.160	3.50
KS-5378,L467	59	54	70	1.185	1.160	3.75
KS-5378,L531	76	64	65	1.185	1.165	5.00
KS-5378,L532	86	72	69	1.185	1.160	5.25
KS-5378,L533	95	80	72	1.185	1.160	5.50
KS-5378,L534	105	88	76	1.185	1.155	5.75
KS-5378,L535	114	96	78	1.180	1.155	6.50
KS-5378,L536	124	104	81	1.180	1.150	7.00
KS-5378,L537	133	112	83	1.180	1.150	7.25
KS-5378,L538	143	120	85	1.180	1.150	7.50
KS-5378,L550	65.5	65.5	54	1.190	1.170	18.50
KS-5378,L551	79	79	64	1.185	1.165	20.50
KS-5378,L552	92	85	61	1.185	1.165	24.00
KS-5378,L553	105	95	70	1.185	1.160	26.00
KS-5378,L554	118	105	79	1.180	1.150	28.25
KS-5378,L555	133	115	74	1.185	1.150	31.75
KS-5378,L556	144	125	81	1.180	1.150	33.75
KS-5378,L560	65.5	55	54	1.190	1.170	4.50
KS-5378,L561	78.75	66	64	1.185	1.165	4.50
KS-5378,L562	92	77	61	1.185	1.165	5.50
KS-5378,L563	105	88	70	1.185	1.160	6.75
KS-5378,L564	118	99	79	1.180	1.150	7.00
KS-5378,L565	131.25	110	74	1.185	1.155	8.00
KS-5378,L566	144.5	121	81	1.180	1.150	8.50
KS-5520,L620	11	11	70	1.190	1.165	1.50
KS-5520,L621	16.5	16.5	75	1.190	1.165	1.25
KS-5520,L622	22	22	80	1.190	1.165	1.50
KS-5520,L623	26.5	26.5	85	1.180	1.150	1.75
KS-5520,L624	31	31	85	1.180	1.150	2.00

Table C (Contd)

Cells	8-hr Dischg Rate in Amps	Finishing Rate in Amps	Sp Gr Range for Complete Dischg in 8 Hrs	Chg Indicator Nominal Sp Gr		Elect per Cell Gals
				White	Red	
KS-5520,L625	34.5	34.5	85	1.180	1.150	2.25
KS-5520,L724	78.5	70	90	1.180	1.150	4.25
KS-5520,L725	85.5	77	90	1.180	1.150	5.75
KS-5520,L726	95	86	100	1.180	1.145	5.25
KS-5520,L728	114	103	90	1.180	1.150	7.25
KS-5520,L729	123.5	111	100	1.180	1.145	6.25
KS-5520,L800	12	12	50	1.195	1.175	1.25
KS-5520,L801	18	18	60	1.190	1.175	1.75
KS-5520,L802	24	24	65	1.190	1.165	1.75
KS-5520,L803	30	30	70	1.190	1.165	2.25
KS-5520,L804	36	36	70	1.190	1.165	2.50
KS-5520,L820	12	12	50	1.195	1.175	1.25
KS-5520,L821	18	18	60	1.190	1.175	1.50
KS-5520,L822	24	24	65	1.190	1.165	1.75
KS-5520,L823	30	30	70	1.190	1.165	2.00
KS-5520,L824	36	36	70	1.190	1.165	2.50
KS-5520,L900	36	36	70	1.190	1.165	2.50
KS-5520,L901	48	48	80	1.180	1.150	3.00
KS-5520,L902	60	60	80	1.180	1.150	3.25
KS-5520,L903	72	65	85	1.180	1.150	4.00
KS-5520,L904	84	72	85	1.180	1.150	4.25
KS-5520,L905	96	80	80	1.180	1.150	5.25
KS-5520,L908	132	112	95	1.180	1.150	6.25
KS-5520,L923	72	65	85	1.180	1.150	4.00
KS-5520,L924	84	72	85	1.180	1.150	4.25
KS-5520,L925	96	80	80	1.180	1.150	5.25
KS-5520,L928	132	112	95	1.180	1.150	6.25

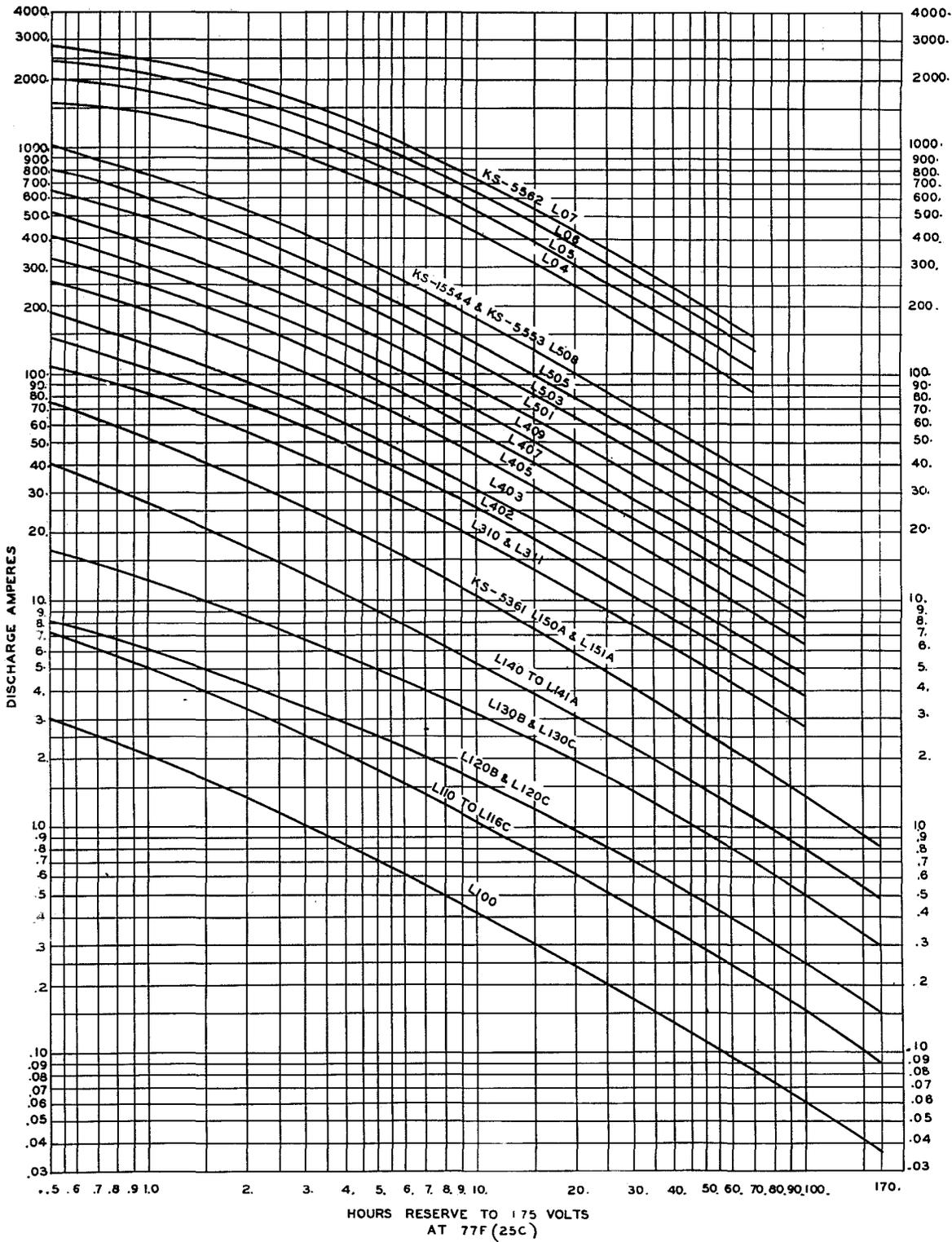
Table D - Cell Data

Cells	8-hr Dischg Rate in Amps	Finishing Rate in Amps	Sp Gr Range for Complete Dischg in 8 Hrs	Elect per Cell Gals
KS-5553, KS-5553-01, and KS-15544				
L310 and L311	22.5	18	75	1
L402	30	24	75	1.25
L403	37.5	30	75	1.75
L405	52.5	42	75	2
L407	67.5	54	75	2.5
L409	82.5	66	75	3.25
L501	105	70	90	4
L503	135	90	90	5
L505	165	110	90	6.25
L508	210	140	90	7.5

Table D (Contd)

<u>Cells</u>	<u>8-hr Dischg Rate in Amps</u>	<u>Finishing Rate in Amps</u>	<u>Sp Gr Range for Complete Dischg in 8 Hrs</u>	<u>Elect per Cell Gals</u>
KS-5562 Gould-Trenton Prior to 1952 and Exide prior to 1954				
L04	500	210	70	26
L05	625	250	70	30
L06	750	290	70	34
L07	875	350	70	41
KS-5562 Exide since 1953				
L04	500	210	58	37.5
L05	625	250	79	35
L06	750	290	83	41.5
L07	875	350	75	51
KS-5562 Gould-Depew Prior to 1952 and Gould-Trenton 1952 to July 1953				
L04	500	210	130	23
L05	625	250	130	28
L06	750	290	130	32
L07	875	350	130	36
KS-5562 Gould-Trenton Since July 1953				
L04	500	210	105	20
L05	625	250	105	23
L06	750	290	105	26
L07	875	350	105	31
KS-15577 Exide				
L1	9	7.5	126	0.37
L6	18.1	16	131	0.80
L7	27	21	133	1.2
L8	36.5	22	124	2.0
L9	43.75	26	125	2.4
L10	54.75	32	126	2.9
KS-15577 Gould				
L1	8.5	4	110	0.20
L6	17.1	9	110	0.50
L7	26	13	110	1.00
L8	38.75	15	90	1.75
L9	46.5	19	95	2.00
L10	54.25	22	90	2.50

ISSUE	2	3		
DATE	8-49	1-53		



BATTERY DISCHARGE CURVES  
TO 1.75 VOLTS PER CELL