

STORAGE BATTERIES

LEAD-ACID ENCLOSED-TYPE

INSTALLATION

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1. GENERAL

A. Introduction

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

1.02 Revision arrows have been used to denote significant changes. This practice is reissued for the following reasons:

- (a) To rate KS-5562 tank cells Mfr Disc. in paragraph 1.06
- (b) To add cell identification in paragraph 1.08
- (c) To add safety admonishments and information to paragraph 2.02
- (d) To rate the KS-21527, L1, eyewash kit, KS-21527, L2, eyewash solution as Mfr Disc., and add the KS-21527, L3, eyewash kit, paragraph 2.03
- (e) To add new safety admonishments, information, and procedures to paragraphs 2.05 through 2.08
- (f) To add safety admonishments and information concerning connecting, disconnecting, and overtightening battery connections to paragraph 2.09
- (g) To add safety admonishments and information concerning specific gravity and temperature readings to paragraph 2.18
- (h) To add information concerning unpacking cell(s) and recording damage at installation to paragraph 4.02
- (i) To remove the arbitrary length charge procedures from Part 5
- (j) To remove the charge to a measured end procedure from Part 5
- (k) To add a new initial charge procedure in Part 5
- (l) To add a procedure for inspecting cells for lead-sulfate crystals in paragraphs 7.01 through 7.06.

1.03 For a listing of practices dealing with lead-acid batteries, refer to Practice 157-000-000, Numerical Index Division 157 and to Practice 169-000-000, Numerical Index Division 169 for Rectifiers and Filament Supplies.

Note 1: General requirements and procedures for lead-acid storage batteries are contained in Practice 157-601-701.

Note 2: Replacement parts and procedures for lead-acid, enclose-type, storage batteries are covered in Practice 157-621-801.

Note 3: Description, requirements, and procedures for the KS-20472 @LINEAGE* 2000 round cell4 are covered in Practice 157-629-701.

Note 4: ♦Visual inspection procedures for the KS-20472 LINEAGE 2000 round cells are covered in Practice 157-629-702.

Note 5: High-voltage application for the KS-20472 LINEAGE 2000 round cells are covered in Practice 157-629-703.♦

Note 6: Description, requirements and procedures for nickel-cadmium engine starting, and control batteries are covered in Practice 157-631-101.

Note 7: Description, requirements and procedures for lead-acid engine starting, and control batteries are covered in Practice 157-633-101.

Note 8: ♦The KS-15577 lead-acid engine starting battery has been rated Mfr Disc., and has been replaced by the KS-15578 nickel-cadmium flooded battery.4

1.04 Lead-acid cells 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 Part 8.)

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

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1.06 **♦**The KS-5562 lead-antimony tank cell is rated Mfr Disc. No further reference will be made of the Mfr Disc. rating of the KS-5562 cell.♦

1.07 When new installations of KS-15544 lead-calcium, KS-5553 lead-antimony, or KS-5562 lead-antimony batteries are planned, their capacity should be calculated on the basis that they will have only 75 percent of their rated capacity available at the end of their normal life.

B. Manufacturers' Identification and Serial Numbers

1.08 **♦Cell Identification Information Location:** Manufacturers identified the factory where a cell was manufactured by a letter or number stamped on one of the terminal posts, usually the negative post and/or a sticker on the battery jar cover. Both the factory location and date of manufacture should be mentioned on records and correspondence. Serial numbering indicates the date cell(s) were shipped (date of manufacture) and the AT&T Technologies individual cell(s) number(s) by manufacturer.

(a) **Manufacturers' Location Identification:**

The manufacturing location identification is outlined as follows:

(1) GOULD* battery cells manufacturing location identification codes follow:

- D-designates the Depew factory (discontinued manufacturing location).
- K-designates the Kankakee factory.
- S-designates the Fort Smith, Arkansas factory.
- T-designates the Trenton factory (discontinued manufacturing location).

(2) **C&D†** battery cells manufacturing location identification codes follow:

- A-designates the Attica factory.
- C-designates the Conshohocken'factory.

- J-designates the Conyers, Georgia factory.

- W-designates the Santa Rosa, California (West Coast) factory (discontinued manufacturing location).

(3) **EXIDE‡** battery cells manufacturing location identification codes follow:

- 1 -designates the Philadelphia, Pennsylvania factory (discontinued manufacturing location).
- 8-designates the Richmond, Kentucky factory.
- g-designates the Chicago, Illinois factory (discontinued manufacturing location).
- 25-designates the San Francisco, California factory (discontinued manufacturing location).

(4) **GLOBE§** battery cells manufacturing location is as follows:

- Milwaukee, Wisconsin factory.

(b) **Serial Numbering:** The serial numbering practice for the different manufacturers is outlined as follows:

(1) The serial number consists of 9 digits. The first 4 digits indicate the year and month of shipment (manufacturing date). The remaining 5 digits indicate the individual AT&T Technologies 5-digit cell identification number.

(2) Serial number blocks of 20,000 serial numbers are assigned to each supplier as follows:

GOULD 00001 through 20000

C&D 20001 through 40000

EXIDE 40001 through 60000

GLOBE 60001 through 80000.

* Trademark of GNB (GOULD).

† Trademark of C&D Batteries.

‡ Trademark of ESB Brands Incorporated.

§ Trademark of GLOBE Battery Division, Johnson Controls.

(3) The entire serial numbers may be on one line or may be separated after the date portion. The 5-digit manufacturers' serial number block portion is usually recycled every month.

Example: 840140024

Where:

84 = 1984 (Shipment Year)

01 = January (Shipment Month)

40024 = Battery No. 40024 shipped by EXIDE in January 1984.4

2. SAFETY PRECAUTIONS AND HANDLING OF CELLS

A. Electrolyte Corrosion and Bodily Protection

2.01 Electrolyte Corrosion and Bodily Protection: #Battery electrolyte is extremely corrosive to most material and human tissue; therefore, exercise extreme care whenever handling battery electrolyte or working around batteries.4

2.02 DANGER: Wear protective equipment such as rubber gloves, rubber aprons, full face mask, and splash-proof goggles when performing any activity involving handling of electrolyte, cell(s) containing electrolyte, or maintenance activities requiring exposure to shock or electrolyte contact from these cells. All lead-acid storage cells/batteries have enormous short circuit capability. Extreme care should be exercised to avoid shorting out cell and/or battery terminals. Shorting a cell or battery with a noninsulated tool can vaporize or throw the tool. ♦The use of INSULATED wrenches is mandatory.4 Personnel permitted access to battery areas should be fully briefed on the hazards of handling lead-acid batteries.

(a) **Corrosion:** Most metal, vegetable, and animal products are corroded by electrolyte, unless it is promptly neutralized.

(b) **Electrolyte Burn Protection: DANGER: Wear protective equipment such as rubber gloves, rubber aprons, full face mask, and splash-proof goggles when performing any activity that involves handling of electrolyte, cells containing electrolyte, or maintenance**

activities requiring exposure to electrolyte from these cells. Bodily protection from electrolyte burns is provided by wearing full face mask, splash-proof goggles, rubber gloves, and rubber apron when working with lead-acid batteries. Rubber gloves protects the hands from electrolyte when working with lead-acid batteries.

(c) Electrical Shock and Burns Protection:

♦**DANGER:** Whenever working around battery strings, any conducting articles on wrists, legs, waist, neck, or head should always be removed.4 A flashlight having a plastic or rubber housing should be used. Body protection is provided by wearing rubber gloves, rubber apron, full face mask, splash-proof goggles, and the use of **insulated tools**. When it is necessary to work on a rack of batteries that cannot be reached from the floor, the use of a wooden ladder is advised. #Whenever it is necessary to work around any string of batteries; rings, wrist watches, metal bracelets, necklaces, belt buckles, etc., should **always** be removed.4

B. First Aid

2.03 First Aid for Electrolyte in Eyes or on Skin: ♦Electrolyte in the eyes or on the skin is a **very** serious matter, and **immediate action** is necessary. Whenever working around batteries or handling battery electrolyte, the following procedures should be observed.

Note: The KS-21527, L1, eyewash kit and the KS-21527, L2, eyewash solution have been Mfr Disc. The replacements are the KS-21527, L3, eyewash kit and the KS-21527, L4, eyewash solution.♦

(a) **Electrolyte Splashes and Burns:** In case of electrolyte splashes, use of the ♦KS-21527, L3, eyewash kit and KS-21527, L4, eyewash solution♦ are recommended. However, if the KS-21527, ♦L3♦ eyewash kit is not available, use the following procedure.

(1) Remove electrolyte splashed on the skin or in the eyes **immediately** by flushing the affected area with large amounts of plain tap water.

(2) In case of electrolyte in the eye, pour water into the inner corner of the eye and allow at

least 1 quart of water to run over the eye and under the eyelid. A drinking fountain near at hand may be utilized for this purpose.

(3) Place eye injuries under the treatment of a physician, preferably an eye specialist, as soon as possible.

(b) **Mounting Eyewash Kits:** In areas where the ♦KS-21527, L3, eyewash kit and KS-21257, L4, eyewash solution♦ are used, containers may be mounted on building columns, along walls, or at the end of battery stands. ♦A KS-21527, L3, eyewash kit must♦ be within reach in approximately 12 **feet** at any point in the battery area. ♦The KS-21527, L3, eyewash kits♦ should be mounted where they can be reached without opening doors, climbing ladders, or using stools.

Note I: The ♦KS-21527, L3,♦ eyewash kit must be separated from other containers in the battery area to minimize the selection of the wrong container in an emergency.

♦**Note 2:** Under federal regulation, expiration dates have appeared on the pint bottles since February 1977. The pint and quart bottles with expiration dates should be disposed of at the time of expiration. The pint bottles with no expiration date may be kept indefinitely.4

C. Neutralizing Agents

2.04 Agents for Neutralizing Lead-Acid Battery Electrolyte: **DANGER: Both electrolyte leakage and neutralizing solutions used for cleanup of electrolyte spills may result in conducting paths with attendant voltage hazards.** ♦Whenever lead-acid battery electrolyte is spilled, it should **immediately** be neutralized. The following can be used for electrolyte neutralization purposes:4

(a) **Soda Solutions:** Soda solutions are used for general neutralization of electrolyte.

(1) **Strong Soda Solutions:** A strong soda solution, used primarily to neutralize spilling or dripping of electrolyte, is made by combining either 2 pounds of baking soda (sodium bicarbonate), or 1 pound of washing soda (sal soda) with 1 gallon of water. One gallon of strong soda solution should neutralize approxi-

mately 3/4 pint of low-specific gravity electrolyte or 1/2 pint of high-specific gravity electrolyte.

(2) **Weak Soda Solutions:** A weak soda solution for neutralizing traces of electrolyte should be 1/8 the strength of the strong soda solution. A weak soda solution is made by combining either 2 pounds of baking soda (sodium bicarbonate), or 1 pound of washing soda (sal soda) with 8 gallons of water.

Note: After using a soda solution, always wipe the neutralized surface with a cloth dampened in clean water.

(b) **Tetrasodium Pyrophosphate:** The use of tetrasodium pyrophosphate (also known as **pyro**) for general electrolyte neutralization has been discontinued for ecological reasons. However, the existing stock may be used up but not reordered. (Pyrophosphate may continue to be used, on an emergency basis, where immediate neutralization of large quantities of electrolyte is mandatory, such as might occur in underground installations. Use a concentration of 1/2 pound to 1 gallon of water.) An acceptable nonpolluting neutralizing agent is available ♦under the name of 'C-39 Hard Surface Cleaner.' This general purpose cleaner is available from AT&T Technologies Service Center, Item No. 5127-1 COMCODE 401753959.4

(c) **Agricultural or Industrial Lime:** **DANGER: Wear eye protection and rubber gloves when using lime on battery electrolyte spills. Wash hands and face thoroughly after use.** When it is necessary to neutralize very large quantities of electrolyte, as in the event of a large spillage, agricultural or industrial lime may be used for this purpose as it is a more economical neutralizer. A 25-pound bag of lime should neutralize the acid in a KS-15544 cell.

(d) **Ammonia Solution:** A household ammonia solution consisting of 1 part ammonia to 2 parts water, should be used for neutralizing electrolyte on clothing. This solution will not cause fabric spotting as readily as a soda solution. Use caution when opening ammonia bottles because of pressure build up within the bottle. Ammonia liquid in vapor form is harmful to the eyes and nose.

Also, do not use ammonia near rotating charging equipment.

Note: Do not use IGEPAL* CO-630 detergent for cleaning. A mild soap solution may be used.

D. Explosion and Fire Prevention

2.05 Explosion and Fire Prevention: DANGER: *All lead-acid batteries generate hydrogen gas, even under open circuit conditions. If not permitted to escape, this gas can build up to explosive concentrations in approximately 1 week for pure lead or lead-calcium cells, and in as little as 2 days for lead-antimony cells. NEVER seal lead-acid cells under any circumstances! When handling, storing, or shipping lead-acid cells, the appropriate vented orange shipping plug MUST be inserted into the open vent hole to allow safe venting of gases and to minimize acid spillage.* The mixture of hydrogen and oxygen gasses given off during charge, due to electrolysis of the water, is **explosive** if in sufficient concentration. A mixture of hydrogen and air is **explosive** if the hydrogen concentration exceeds 4 percent by volume. The following admonishments, precautions, and procedures should always be followed.

(a) **Static Electricity Sparks: DANGER:** *Avoid creating sparks, including those from static electricity, or the use of an open flame near batteries since the gas generated by batteries is highly explosive. Before performing each individual work operation, firmly touch a ground to discharge the static electricity from your body. Electrolyte level should NEVER be allowed to drop below the end of the antiexplosion funnel.* Take precautions against static sparks at all times and especially while taking hydrometer or thermometer readings or when installing new vents of any type while cells are in service. These precautions should be observed when working on cells with or without antiexplosion features (see Practice 157-601-701) because of the possibility of cover seal leaks, post seal leaks, or containers, which would bypass the antiexplosion feature (see Practice 157-601-701.) Where static electricity is a problem, the wearing of leather-soled shoes is recommend-

ed. Also, a slightly damp cloth, rather than a dry cloth, should be used to wipe plastic containers. To discharge static electricity from body, touch any grounded rack or frame.⁴

(b) **Charge and Discharge Explosion Safety:**

Under normal float, discharge, and recharge conditions, no explosion hazard exists with properly vented KS-15544 lead-calcium batteries. All lead-antimony batteries may contain an explosive atmosphere even under normal float charge conditions. Regardless of the type of battery, it is prudent to always take precautions against static sparks. During boost charge (2.3 volts or greater), all the batteries covered in this practice contain an explosive atmosphere.⁴ **If a spark (as from a static discharge) enters the cell(s) under these conditions, an explosion may occur. For maximum safety, DO NOT handle (avoid all contact with) cells on boost charge and for 24 hours after completion of boost charge.**

(c) **Explosion Precautions:** Special precautions should be used while taking hydrometer or thermometer measurements or when installing a new vent or funnel while batteries are in service. Battery rooms and enclosures should be ventilated. Flames, arcs, sparks, etc, should be avoided in the vicinity of the battery. At no time should electrolyte level be allowed to drop below the minimum. The supervisor should ensure that all antiexplosion precautions of this practice and local instructions are followed. (See Practices 157-601-101 and 157-601-701.)

(d) **Battery Connections:** Do **not** loosen or remove battery connections while cells are gassing or discharging unless it is absolutely necessary. If removal of connection is necessary during this period, follow procedures specified in subparagraphs (a), (b), (c), and in paragraph 2.09.

(e) **Battery Electrolyte Leakage or Spillage:**

Leakage or spillage of battery electrolyte should **not** be allowed, especially where such leakage or spillage might form a low resistance arc path to ground or between different potentials. Avoid electrolyte leakage or spillage which, in addition to the electrical path hazards, will cause corrosion.

(f) **Battery Electrolyte Level:** Electrolyte level should **NOT** be allowed to fall below

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minimum since this allows the flame-arrestor vents to be bypassed.

(g) **Electrolyte Overflow:** Electrolyte overflow from the vent funnel (flame arrestor) indicates clogged vents, which constitutes an explosion hazard. If this occurs, replace the vent funnel.

(h) **Battery Terminal Ends:** The positive (+) and negative (-) ends of battery strings shall not be adjacent.

2.06 **Test Leads:** Whenever making voltage measurements, observe the following precautions:

- Use extreme caution when making voltage measurements to prevent accidental grounding of the leads during the test operations.
- Secure connections at the meter end.
- The test leads should never touch each other or become grounded.⁴
- In no case should connections at the meter end be removed without first disconnecting the test leads from the battery.
- The test lead connections at the battery should be removed immediately after each voltage measurement is taken.

2.07 **DANGER:** *Avoid creating sparks, including those from static electricity, or the use of an open flame near batteries since the gas is explosive when sufficiently concentrated. Before performing each individual work operation, firmly touch, a grounded rack, or an inter-cell connector near the grounded end of the battery, to discharge the static electricity from the body.*

2.08 **DANGER:** *Do not allow gas vents (flame arrestor) to become clogged as explosion due to internal pressure may result. Such an explosion may short circuit other cells and lead to a fire.*

E. Battery Connections Replacement and Installation

2.09 **Battery Connections and Use of NO-OX-ID A* Compound: DANGER:** *Observe the precautions in this paragraph and paragraph 2.05 before loosening or removing battery connections while cells are gassing or discharging as sparks may occur and a potential fire hazard exists.* ♦To connect or disconnect battery connections, proceed as follows:⁴

(a) **Connecting or Disconnecting Battery Connections: @Caution:** Overtightening of the intercell connectors could strip the bolt and/or nut threads resulting in loose connections.⁴ When opening or replacing connections on battery cells with only two terminals, it is recommended that a procedure be employed similar to that illustrated by Fig. 1 in which a temporary switch is connected from terminal to terminal across the intercell connector which is to be removed. The main purpose of the switch connection is to eliminate a potential arcing hazard. A secondary purpose of the switch is to prevent possible loss of service in case power fails while the intercell connector is disconnected. The switch is to be closed before opening or replacing the battery connections. The size of the switch strap and temporary wiring must be sufficient to carry the load under power failure conditions.

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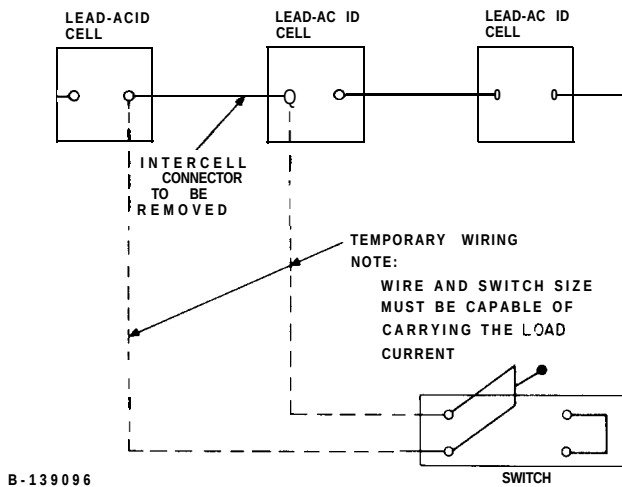


Fig. 1 -Typical Temporary Switch Connected to Remove Arc Hazard

(b) **Caution:** It is recommended that the temporary knife switch be used, and that the switch contacts be kept closed at all times while working on single-string battery plants. This procedure is recommended even when parallel intercell connectors are used to guard against possible broken posts, connection corrosion, or loose connections on the mate (parallel) intercell connector and posts. Use of the switch is mandatory in all plants powering office equipment which may be adversely affected by rectifier noise or transients which are likely to be present when the battery is not solidly connected as a filter across the rectifier. The switch illustrated in Fig. 1 is not absolutely required with cells having four terminals. On batteries with four terminals, remove the connector(s) from one terminal at a time, without loosening the parallel connectors on the other terminal. Clean and replace the connector(s) on one terminal before proceeding to the parallel terminal. If it is necessary to break all connectors to a $\$$ -terminal cell simultaneously, the use of a temporary switch is mandatory.⁴

(c) **General Maintenance:** If a connection appears corroded or damaged (see Practice 157-601-702), open the connection after first observing the precautions in subparagraphs (a) and (b), and clean the corroded posts, intercell connector, con-

tact surfaces, and terminal details using a cloth dampened in a **strong soda solution** followed by wiping with a cloth dampened in clear water.

(d) **DANGER:** Keep the temporary switch closed at all times while working on a connector. Always use insulated tools. Do not allow neutralizing solutions to enter the cell. Sandpaper, stiff wire brushes, or other abrasive tools should not be used on intercell connectors or fastening hardware as this will remove the protective lead coating. The four sides of each terminal post should be sandpapered to a bright finish without abrading the intercell connectors or the fastening hardware and coated with NO-OX-ID A compound. The **contact** areas of intercell connectors and terminal details from which corrosion has been removed should be cleaned by wiping or brushing with a soft brush and then coated with a thin coating of NO-OX-ID A compound. If copper surface on connector shows through lead plating, connector should be replaced.

(e) **DANGER:** Do not use an open flame or direct heat on the can of NO-OX-ID A compound. Avoid bodily contact with the hot liquid. Sandpaper, stiff wire brushes, or other abrasive tools should not be used on intercell connectors or fastening hardware as this will remove the protective lead coating.⁴ Clean and remove corrosion from the terminal mounting bolt holes of the battery terminal posts using a round, nonmetallic, bristle brush similar to a baby nipple brush (brush to be obtained locally). Dip the brush in a **strong soda solution**, bump excess solution from the brush, and scrub bolt holes thoroughly, being careful to avoid contact with the adjacent cell connector. [See paragraph 2.04, subparagraph (a)]. Rinse solution from brush in clear water, scrub any soda solution from the bolt holes; again, exercise care to avoid contact with the adjacent cell connector. Wipe the bolt hole with a clean lint-free cloth and apply a light coating of NO-OX-ID A compound to the entire inside of the cleaned bolt hole.

Note 1: The NO-OX-ID A compound can be heated by placing the can of compound in hot water of 160°F or more. Heat the compound until it can be easily applied with a brush.

Note 2: The NO-OX-ID A compound is now supplied in tube containers which greatly improves application and is normally applied at room temperature. If using compound supplied in the old containers, see DANGER and Note 1.

Note 3: An open flame or direct heat should **not** be applied to the container of NO-OX-ID A compound.

Note 4: Neutralizing solution shall **not** be allowed to enter the cell, as this would weaken the electrolyte.

(f) If a temporary switch was used, open the switch only after reconnecting the intercell connector; then, remove the switch and wiring. If a temporary switch was not used, close the opened connections. Tighten all connections securely and wipe off excess compound. Two insulated wrenches should always be used to tighten a connection in order to avoid the possible breakage of the lead posts or damage to nuts and to insure a tight connection.

(g) **Electrolyte Creepage:** Green or blue copper-sulfate on a part, usually an intercell connector or a terminal detail, indicates that electrolyte has penetrated its lead coating and is reacting with the copper. Any such part, other than a post, should be replaced and all associated surfaces treated in accordance with subparagraphs (b), (c), and (d). Cracked seal nuts should be replaced as recommended in Practice 157-621-801.

2.10 Containers and Covers: Cell containers and covers should be kept clean and efforts should be made to prevent damage of containers. Use the following outline for care and maintenance of containers.

(a) Replace cells having cracked or leaking containers. Such cells present a fire hazard. Cells should be replaced by like cells (see Practice 157-601-101). See paragraph 2.16 for allowable limits on scratches at installation. Refer to Practices 157-601-703 and PEL 7367 for more detailed information and photographs on container and cover cracks. See Practice 157-601-701 for instructions on temporarily sealing cracks in plastic jars with acid-resistant tape.

(b) Sprayed or dripped electrolyte on containers or covers should be neutralized with a **weak soda solution** followed by a plain water rinse. See paragraph 2.04, subparagraph (a).

(c) **Warning: Plastic battery containers can be damaged by cleaning with solvents or petroleum based cleaners.** Do not expose or clean plastic containers with petrolatum or solvents such as kerosene, gasoline, or petroleum spirits which is the solvent in most cleaning compounds as well as the thinner in most waxes and polishes. Petroleum spirits and solvents seek out points of residual stress, causing cracks, crazing, and eventual failure. Do not use commercial detergents such as IGEPAL CO-630 on plastic jars as this can lead to crazing or cracking of the jars. A mild soap may be used (see Practice 157-601-701).

(d) Discolored rubber containers may be refinished by washing with a **weak soda solution**, followed by a water rinse.

F. Handling large Carboys of Electrolyte

2.11 The large carboys of electrolyte solution shall be left in their shipping cases. Small containers of 1-gallon size are generally used. This is to reduce the chance for container breakage and limit the damage if there is breakage.

G. Limits on Tipping of lead-Acid Cells

2.12 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 tank cells, may be tipped as much as 30 degrees momentarily in order to pass through windows or to circumvent other obstructions. See paragraph 4.08 for data on electrolyte spillage and plate exposure.

H. lead-Acid Cell Shipping Pallets

2.13 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.

I. Handling and Uncrating lead-Acid Cells

2.14 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, lifting platforms, miscellaneous metal parts, tools, etc.

J. Exposure of Lead-Acid Cell Plastic Containers to Solvents, Petrolatum, or Detergents

2.15 Warning: Do not use solvents to clean plastic battery containers. Avoid exposure of plastic containers to petrolatum or solvents, such as kerosene, gasoline, petroleum spirits, cleaning compounds, commercial detergents, such as IGEPAL CO-630, and the thinner in waxes and polishes. Such materials tend to produce crazing or cracks in plastic.

K. Limits on Scratches and Crazing of lead-Acid Cell Containers at Installation

2.16 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. 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.

L. Lifting Lead-Acid Cells Into Position

2.17 Cells having soft rubber pads on the bottom, such as KS-5562 tank cells (Mfr Disc.), 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 company local engineering.

M. Specific Gravity and Temperature Readings

2.18 **Specific Gravity, Reference Temperature and Floating Ball Charge Indicators:** **DANGER: When taking specific gravity readings, the open end of the hydrometer shall be covered with an acid-resistant material while moving it from cell to cell to avoid splashing or**

throwing the electrolyte. To check these requirements, proceed as follows:

(a) **Hydrometer Types:** Use the KS-5499, L1305 (old) or L1306 (new) syringe-type hydrometer for low-gravity cells and the KS-5499, L1307 (old) or L1308 (new) syringe-type hydrometer for high-gravity cells. (See Table A for specific gravity requirements.)

(b) **Reference Temperature and Effect of Temperature on Specific Gravity: Warning: Never insert a thermometer into the electrolyte withdrawal tube or use a mercury-filled thermometer to take temperature measurements and readings. Thermometers used in lead-antimony, lead-calcium, and KS-20472 LINEAGE 2000 round cell shall not be interchanged since they will contaminate the electrolyte.** Use the KS-5499, L1352, thermometer for cells of 100-ampere hours or less and the KS-5499, L1353, thermometer for cells over 100-ampere hours. Specific gravity readings and electrolyte temperature readings must be taken within a few minutes of each other. The thermometers now being supplied have scales for correcting to the proper reference temperature of 77°F. If a thermometer with correction scale is not available, calculate the correct specific gravity by adding 1 point (0.001) for each 3°F that the electrolyte temperature is above 77°F or by subtracting 1 point (0.001) for each 3°F that the electrolyte temperature is below 77°F.

Note: Thermometers in which the indicating liquid has separated shall not be used and shall be discarded.

(c) **Specific Gravity Readings of Cells With Electrolyte Withdrawal Tubes:** Specific gravity measurements and readings of lead-acid cells with electrolyte withdrawal tubes are taken by first exhausting the hydrometer bulb with the flexible tube inserted in the battery water filler funnel. Then, with the bulb still held depressed, insert the flexible tube into the battery hydrometer tube located in the corner of the battery cover. Releasing the bulb will draw battery electrolyte into the hydrometer, which must then be carefully removed to facilitate reading the specific gravity number on the hydrometer float at the surface of the electrolyte. The hydrometer must be exhausted in the water filler funnel (not the small

♦TABLE AC

CELL FLOAT VOLTAGE AND SPECIFIC GRAVITY
REQUIREMENT CHART

DESCRIPTION OF OPERATION	LOW-GRAVITY CELLS, LIMITS	HIGH-GRAVITY CELLS, LIMITS
Pilot-cell and emergency cell float voltage reading	2.17 ± 0.05 volts/cell	Lead-calcium (2.30 ± 0.05 volts/ cell) Lead-antimony (2.25 ± 0.05 volts/ cell)
Battery float voltage reading	2.17 ± 0.01 volts/cell	Lead-calcium (2.30 ± 0.01 volts/ cell) Lead-antimony (2.25 ± 0.01 volts/ cell)
Emergency cell specific gravity	No lower than 1.180	No lower than 1.180
Pilot-cell specific gravity reading (corrected)	1.210 ± 0.010	1.300 ± 0.010
Individual cell voltage readings	2.17 ± 0.05 volts/cell	Lead-calcium (2.30 ± 0.05 volts/ cell) Lead-antimony (2.25 ± 0.05 volts/ cell)
Clean and inspect		
Individual cell specific gravity readings	1.210 ± 0.010	1.300 ± 0.010
Average battery float voltage (under varying voltage and load conditions)	2.17 ± 0.01 volts/cell	Lead-calcium (2.30 ± 0.01 volts/ cell) Lead-antimony (2.25 ± 0.01 volts/ cell)
Water analysis		
Electrolyte level		

hydrometer tube) of the cell from which the electrolyte was removed. This procedure should prevent battery electrolyte from splattering from the hydrometer flexible lube during handling.

(d) **Specific Gravity Readings of Cells Without Electrolyte Withdrawal Tubes:**

Warning: Hydrometers used in lead-antimony, lead-calcium, and KS-20472 cylindrical batteries shall not be interchanged since they will contaminate the electrolyte. Specific gravity measurements and reading of cells without electrolyte withdrawal tubes are taken by inserting the hydrometer through the opening which is used for the addition of water.

However, readings must not be considered accurate unless 10 weeks have elapsed since charging or adding water for lead-calcium cells or 2 weeks for lead-antimony cells. Slowly fill and empty the hydrometer several times before recording readings in order to wet the float, mix the electrolyte, and equalize the temperature of the hydrometer and electrolyte. Exercise care to ensure that the top of the hydrometer does not touch the stop in the hydrometer bulb since this would cause an erroneous reading. Exercise care to avoid dripping or spraying electrolyte from the hydrometer tube.

(e) **Assembling Hydrometer Syringe: DANGER: In order to avoid possible serious**

cuts from broken glass, extreme care should be used in assembling the hydrometer syringe. If the hydrometer has previously been used, it may possibly contain some electrolyte clinging to the wall of the glass barrel or rubber hose. Goggles should be used in assembly operations to protect the eyes. [See Steps (1) through (4).]

(1) Remove any mold seam fins from those surfaces of the rubber parts which in assembly fit against the glass barrel.

(2) Before assembling any rubber parts to the glass barrel, wrap several thicknesses of heavy cloth around the barrel to protect the hands.

(3) Always wet the rubber parts and that portion of the glass barrel where the fitting is to take place prior to assembly operations.

(4) After performing Steps (1), (2), and (3), fit the rubber parts to the glass barrel.

(f) ***Floating Ball Charge Indicators:*** Charge indicators are furnished on some smaller cells. The indicators are wax balls of selected specific gravity. The three colored ball indicators (blue-green, white, and red) provide the following specific gravity indications:

(1) The blue-green ball drops when the specific gravity falls to 1.195 ± 0.002 . This ball drops first on discharge.

(2) The red ball drops when the specific gravity decreases by an amount representing between 63- and 69-percent discharge from the full charge value.

(3) The white ball drops when the specific gravity is approximately half-way between the gravity requirements of the blue-green and red indicators.

Note: The indicators in Steps (1), (2), and (3) assume a well mixed electrolyte, at the high level, with a temperature of 77°F.

(g) ***Specific Gravity Out of Range:*** Specific gravity measurements below the required range are rare and indicates that the cell is self-

discharging and consequently losing capacity. Boost charge a cell when specific gravity is below the required minimum. If boost charging permanently corrects the condition, no action needs to be taken. If the specific gravity is still low after boost charging, or if the condition reappears within a year of boost charging, replace the cell.

N. Electrolyte level Indicator Floats

2.19 Electrolyte Level Indicator Floats: Electrolyte level of rubber jar cells is indicated by electrolyte level float indicators. The indicator consists of a float and a float guide (Fig. 2). The electrolyte indicator for the EXIDE KS-5562 cells is fitted with a transparent cover over the exposed stem part of the float. The cover is etched with lines to indicate the high and low level of the electrolyte. The electrolyte level indicator for the GOULD cells without a cover has the float stem colored to indicate the electrolyte level. The minimum level of electrolyte is indicated when the top of the float stem is flush (or level) with the top of the float guide.

(a) ***Assembling EXIDE Electrolyte Level Indicator Floats:*** To assemble EXIDE electrolyte level indicator floats having float covers, bend both ears of the lead strip at right angles to the body of the strip using a pair of short nose pliers. Insert the float stem into the bottom of the float tube body. Secure the lead strip to the tube body by pressing the bent ends of the strip into the side holes on the body of the tube.

(b) ***Assembling GOULD Electrolyte Level Indicator Floats:*** To assemble GOULD electrolyte level indicator floats, remove the hard rubber packing gland from the barrel and place the float guide in the gland with the small opening at the top. Place the float stem through the float guide and place the barrel of the float body into the cell cover with the bulb part of the float body in the well. Then screw the gland snugly into place. When the float guide is correctly placed, the top of the guide extends past the top of the gland approximately 1/16 inch.

(c) ***Checking Electrolyte Level Indicator Floats:*** Floats shall be free to move with electrolyte level changes. To check float indicators equipped without cover, depress the float indicator and observe that the float does not stick when released.

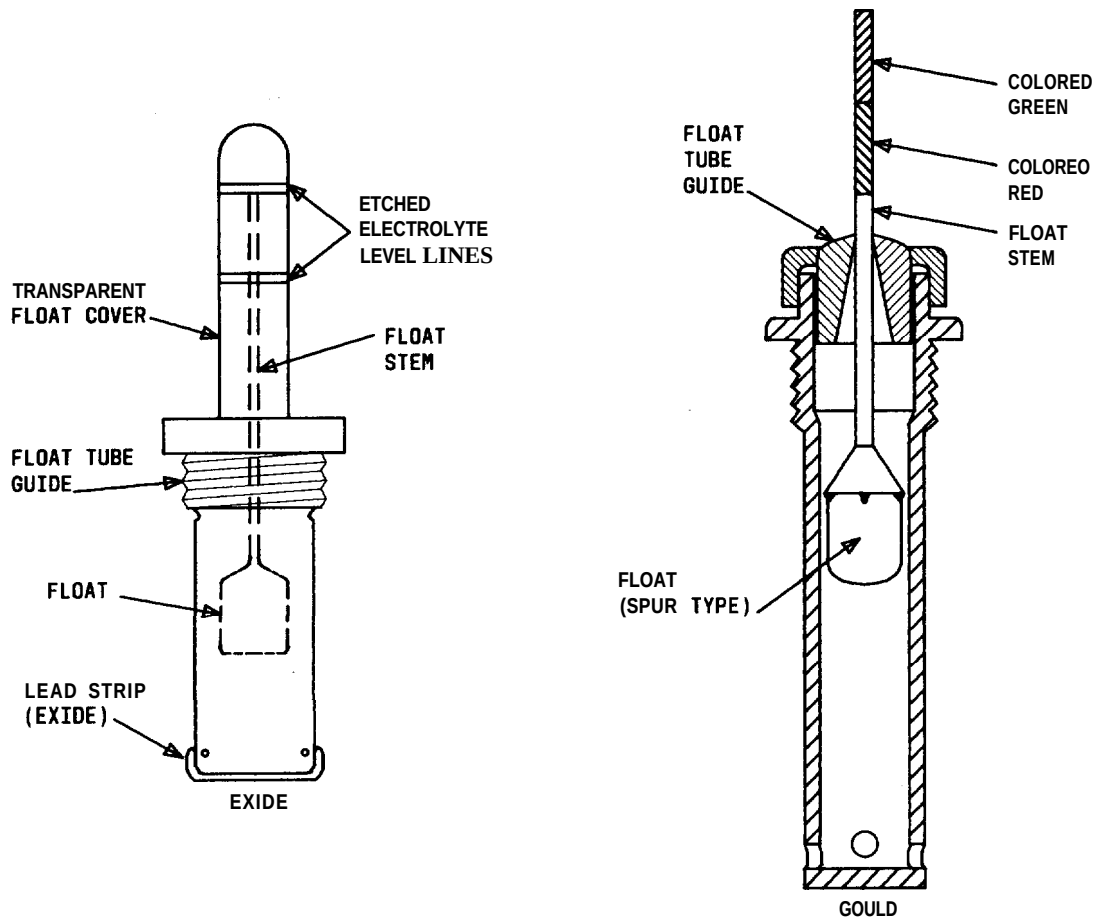


Fig. P-Rubber Battery Jar Electrolyte Level Indicator Floats

3. LOCATING AND INSTALLATION OF CELLS

A. Exposure of Cells to Radiant Heat

3.01 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 local engineering shall be notified. Local engineering may wish to provide shields for the radiators, blinds for the windows, or special ventilation for the 3-tier racks.

Note: The temperature differences between cells of the same string arranged in two or three tiers shall not exceed 5°F.

B. Placement of KYDEX, Plastic, or Rubber Sheets Under Lead-Acid Cells

3.02 Normally, cells are placed on KYDEX sheets (or sheets of similar material), although flexible sheets of semihard rubber or plastic may be specified. When 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.

C. Leveling and Aligning Lead-Acid Cells

3.03 When KS-5562 tank cells are installed on the floor, the floor is to be leveled and finished in advance by the local engineering. Terminals shall be

in alignment within $\pm 1/16$ inch for each cell and within $\pm 1/4$ inch for the line of cells. Cells and counter-cells shall be level. Gauge by eye along top edges for proper appearance and at sides which should be approximately vertical and uniformly spaced. Slight irregularities of floor or cell may be compensated for by using (under the cells) shims made of thin strips of rubber or plastic, preferably of the type used on battery stands. If more than slight shimming is necessary because of floor condition, the floor shall be leveled. Sides of large cells that are slightly out of plumb or bulging slightly are considered acceptable provided that they meet the criteria established in paragraphs 3.06 and 3.07.

D. Installing Cells on Center line and Separating Opposite Ends of Strings

3.04 Floor plans for floor-mounted cells have rectangles corresponding to the maximum dimensions permitted for the battery string. When installed, the cells are located symmetrically on the longitudinal center line of the rectangle. Unless otherwise specified in the job information, the bottom of the cell at either end of the rectangle is located with its transverse centerline $9-1/16$ inches from the end of the rectangle. Standard spacing (see paragraph 3.06) will locate the other cells and prevent cells from touching each other.

E. Placing Lead-Acid Cells on Shelves or Racks

3.05 Floor plans for shelf- or rack-mounted cells have rectangles corresponding to the cabinet or rack. Unless otherwise specified in job information, the cells are located symmetrically in the space reserved for them on the shelf or rack. Metal battery racks shall be grounded in accordance with Practice 802-001-193. For more detailed information on battery stands for various types of power plants, refer to Practices 802-125-150 through 802-125-152 and Practices 802-126-150 through 802-126-154.

F. Spacing of lead-Acid Cells

3.06 **DANGER: Rack-mounted 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.** Either the cell center-to-center or the terminal post face-to-face (adjacent

faces) values in Table B may be used to locate cells. In general, spacing is determined by the dimensions of the rigid inter-cell connectors. Otherwise, cells, cell combination, or groups of cells should have approximately $3/8$ - to $5/8$ -inch space between the top edge of cells, cases, or trays. Spacing between KS-5562 tank cells should be $1/8$ -inch minimum.

TABLE B
LEAD-ACID CELL SPACING

CELLS MOUNTED WITH PLATES PARALLEL TO STAND LENGTH	CELL CENTER TO CENTER (INCHES)	POST FACE TO FACE (INCHES)
KS-5553 — KS-15544 Lists 407 to 409 Lists 501 to 503	11-1/4 15	4-1/16 6-1/2
FLOOR-MOUNTED CELLS		
KS-5562 All Lists	18-7/16	7-5/16

G. Spacing Between Rows

3.07 The spacing between rows of containers shall range from at least $3/4$ inch on small cells to at least 3 inches on large cells, such as the KS-5562 tank cells.

4. PREPARATION OF CELLS AND ACCESSORIES

A. Counter-cells

4.01 Wet counter-cells are rated Mfr Disc. due to the explosion hazard of the gas produced during normal operation. Solid-state CEMF (counter electromotive force) cells are now available. (See Practice 157-322-701.)

B. Unpacking Cell(s) and Recording Damage at Installation

4.02 Use the following guidelines to ensure proper condition of new cells.

(1) **Before Signing Bill of Lading:** If indications of spillage during shipment are noted prior to acceptance from the carrier, it should be recorded on the bill of lading before signing.

(2) **Electrolyte Spillage Indications:** If the electrolyte level is below the cell plates (for more than 20 minutes), the battery is not acceptable for installation because excessive spillage is indicated. If the electrolyte is 1/2 inch below the low-level marking on the battery jar (transparent plastic jar) but above the cap, fill with 1.210 ± 0.005 specific gravity electrolyte to the **low-level mark** on the battery jar.

(3) **Electrolyte Level:** At the time of manufacture, the electrolyte level of each lead-acid cell is adjusted between the level lines when the cells are float charged at 2.17 volts. Because of outgassing during shipment, it is not unusual to receive cells having electrolyte levels below the low level mark. Therefore, spillage should be suspected only when electrolyte levels are more than 1/2 inch below the low-level mark.

(4) **Pallets:** Lead-acid 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.

(5) **Before Unpacking Lead-Acid Cells:** Before unpacking a cell, examine the shipping container. Record signs of electrolyte spillage or external damage.

(6) **Unpacking Lead-Acid Cells:** If possible, note spillage before unpacking. Do not tip cells more than 25 degrees to prevent electrolyte spillage through the vent.

(7) **Unpacking Lead-Acid Cell Vent Funnels:** Unpack vent funnels and store in a convenient protected location until final tightening of intercell connectors is completed.

(8) **After Unpacking Lead-Acid Cells:** After unpacking, check electrolyte level of cells immediately after unpacking. Record any action taken in the initial charge report.

(9) **Electrolyte Spillage: DANGER: Wear eye protection and rubber gloves when using lime on electrolyte spills. Wash face and hands thoroughly after use.** If large spillage has occurred, it is permissible to use agricultural or industrial lime instead of soda for neutralization before cleanup. For this type spillage, the lime is sprinkled on the spillage, allowed to absorb the electrolyte, and then swept up and disposed of in the proper manner.

(10) **Specific Gravity:** After checking electrolyte level, measure and record specific gravity before the cell is hoisted into place. (See paragraph 2.18.)

(11) **Specific Gravity and Temperature Correction:** The specific gravity of installed and charged cells shall be 1.210 ± 0.010 . See specific gravity readings and temperature corrections in paragraph 2.18.

(12) **Lead-Acid Cell Replacement:** Any visible damage shall be noted in the records prior to seeking replacement. If it becomes necessary to return any filled cell to the manufacturer because of low electrolyte level, add 1.210 specific gravity acid immediately if available; otherwise, add approved water before shipment as necessary to bring electrolyte level to minimum and note action taken in report to manufacturer.

C. Lead-Acid Storage Cell Accessories and Shipping Plugs

4.03 **DANGER: Remove shipping plugs and install explosion proof vents and filling funnels before interconnecting cells. The electrolyte in cells with antiexplosion features shall be at the minimum level or higher to assure proper functioning of the antiexplosion features.** For batteries with the vents shipped in place, remove tape and packing material.

D. Use of Lead-Acid Cell Filling Funnels

4.04 **Warning: To prevent overflow, do not add water above minimum level before charge.** Where there is a choice, locate the filling funnel on the side most accessible for water additions. Lead-antimony funnels should not be installed in KS-15544 or other cells with lead-calcium grids. EXIDE lead-calcium funnels have a green or blue dis-

tinguishing band, while EXIDE lead-antimony funnels have no marking. All C&D and present production of GOULD lead-alloy funnels are of lead-calcium, thus they provide 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 clean water prior to insertion in a cell of a different type. Install level indicator, if any. Check the level indicator by depressing with the finger to be sure that it is not sticking.

E. Disposition of lead-Acid Cell Shipping Plugs

4.05 Some shipping plugs, such as those on the KS-15754 and most KS-5361 and KS-15886 (Mfr Disc.) cells, are designed for permanent use in the top of filling funnels as spray caps. Others, originally meant for discard, are now used by some locations permanently in the vents to prevent dirt or other foreign matter from entering the cells. For this reason, all shipping plugs for the battery cells shall be installed on the cells or turned over to the local engineering.

F. Hydrometers

4.06 **Warning: Hydrometers used in lead-antimony cells should not be used in lead-calcium cells and vice versa since this would contaminate the electrolyte. Hydrometers used in KS-20472 LINEAGE 2000 round cell should not be used in lead-antimony or lead-calcium cells and vice versa since this would contaminate the electrolyte.**

4.07 Check and assemble hydrometers as follows:

- (a) **Hydrometers 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.

- (b) **Assembling the Hydrometer Syringe:**
DANGER: In order to avoid possible serious cuts from broken glass, extreme care should be used in assembling the hydrometer syringe. If the hydrometer was previously used and may possibly contain some electrolyte clinging to the wall of the glass barrel or rubber hose, rinse thoroughly with water before assembly operations. Goggles should be used in assembly operations to protect the eyes. To assemble the hydrometer syringe, proceed as follows:

- (1) Remove any mold seam fins from those surfaces of the rubber parts which, in assembly, fit against the glass barrel.
- (2) Before assembling any rubber parts to the glass barrel, wrap several thicknesses of heavy cloth around the barrel to protect the hands.
- (3) Always use water to wet the rubber parts, and ensure that those portions of the glass barrel where the fitting is to take place are wet prior to assembly operations.
- (4) After performing Steps (1), (2), and (3), fit the rubber parts to glass barrel.

G. Lead-Acid Cell Electrolyte Spillage and Plate Exposure

4.08 Check the electrolyte level of cells which are shipped filled with electrolyte immediately after unpacking. If possible, spillage should be noted before unpacking. Record any action taken in the initial charge report.

- (a) **Before Signing Bill of Lading:** 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) **Cell Plate Exposure:** Cells are not acceptable that have had more than 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) Cell Replacement: If it becomes necessary to return any cell to the manufacturer because of low electrolyte level, add approved water, if available; otherwise, add water before shipment, as necessary, to bring electrolyte level to minimum. This should be a subject for a JIM (Job Information Memoranda) if the product has not been turned over to the company, or for an engineering complaint if it has been accepted by the company.

H. Installing Intercell Connectors

4.09 **DANGER: Avoid sparks during gassing.**

Connections shall not be made or opened while cells are gassing or for 24 hours thereafter. (See the explosion prevention admonishments and procedures in paragraphs 2.05 through 2.09.) The battery charger should be either shut down or adjusted to just carry the load, if any. Do not use an open flame or direct heat on the can of NO-OX-ID A compound. Avoid bodily contact with the hot liquid.

At no time shall battery intercell connectors be filed, scraped, sandpapered, or brushed with a stiff wire brush as this will remove the protective lead coating. Apply NO-OX-ID A (R-3266) compound, using a type-writer brush or similar stiff brush to coat all post and intercell connector surfaces in contact with the post and the threads of connector bolts. The entire intercell connector shall not be coated. 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 inter-cell 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. Two wrenches should be used to tighten a connection to avoid possible breakage of the lead posts.

4.10 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. Connection prepared on the job may be made with lead-coated copper or with lead-alloy terminal lugs and rubber-covered cable, stranded preferred. The size of the lead may be the same as the lead running to the battery, and except for 100-ampere-hour and smaller cells,

the lead shall not be smaller than No. 8. For further information on bus bars and wiring in power plant installations, see Practice 802-005-180.

I. Equalizing Voltages of Strings to be Paralleled

4.11 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.

J. Lead-Acid Cell Terminal Post Tilting

4.12 The KS-15544 and KS-5553 cells, manufactured by GOULD, sometimes arrive with tilted battery terminals. This is caused by shocks received during shipping. A slight amount of tilt of these posts is acceptable. However, if the tilting is so severe that the lead bushing under the plastic nut is visible, the condition should be corrected. This is done by removing the plastic nut, straightening the post with a rubber mallet, and replacing the plastic nut.

5. INITIAL CHARGE

A. Temperature Reference Cell Selection

5.01 During the installation period, a cell shall be selected and designated as the **temperature reference cell** within each tier. The temperature reference cell is selected for the purpose of temperature measurement. Temperature reference cells shall not be located near a window or radiator.

B. Charging Cells Added To A String

5.02 **DANGER: Wells should NOT be handled during boost charge or 24 hours thereafter.** 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 impractical, 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.

5.03 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.

5.04 When replacing a 70-cell tapped battery, it is not always practical to replace the entire battery the same day. This results in high voltage on new groups and low voltage on old groups during installation. This condition is aggravated where the new groups are lead-calcium and the old groups are 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), however, not so low that the voltage of the old cells is less than 2.06 volts.

C. Maximum Time Until Initial Charge of Cells Shipped Charged and Wet

5.05 DANGER: Wells should NOT be handled during initial or boost charge or for 24 hours thereafter.

4 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 followed may be based on convenience.

(a) Maintain the battery on continuous float charge operation (see Practice 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 Practice 157-601-701) every 6 to 8 weeks until the normal initial charge can be administered.

5.06 Where none of these three methods is feasible, and open circuit has been **greater** than 3 months for lead-antimony or **greater** than 6 months for lead-calcium, the company local engineering shall be notified and the regular initial charge shall be given. If inspection reveals evidence of positive plate lead-sulfate crystals after completion of the above charge, a second initial charge shall be given until lead-sulfate crystals are removed. If lead-sulfate crystals are still present after the second

initial charge, discuss disposition through supervisory channels. Cells with visible evidence of lead-sulfate crystals are not acceptable for turnover. See Practices 157-629-701 and 157-629-703.

Note: Special charging may not compensate entirely for long periods on open circuit, especially with high-electrolyte temperature; therefore, some loss of total cell life is to be anticipated under such conditions.

D. Maximum Time Until Initial Charge of Cells Shipped Charged and Dry

5.07 For cells shipped charged and dry, the initial charge shall be administered within 1 year after shipment, and no more than 18 hours after filling.

E. Maximum Temperature Initial Charge

5.08 Cell temperatures higher than 110°F are not permissible, except during the last 3 hours of the initial charge. The absolute maximum temperature allowed is 120°F. However, appreciably lower temperatures, 80°F or less, are preferred at all times.

F. Initial Charge of lead-Acid Cells

5.09 An initial charge should be given to all batteries prior to turnover to the customer. The purpose of an initial charge is to compensate for self-discharge that has taken place in the interval between cell manufacture and installation. The initial charge voltage shall be in the range of 2.5 and 2.55 volts per cell. Temperature shall be determined by designating a **temperature reference cell** as described in paragraph 5.01. Cell temperatures higher than 110°F are not permissible during initial charge.

G. Procedure for Initial Charge

5.10 DANGER: Cells should not be handled during initial or boost charge or for 24 hours thereafter. Unless the complete string can be charged in its final configuration in the battery stands, it is recommended that the string be divided into groups not to exceed 70 cells for initial charge. Generally 5 amperes per string is all that is required to initial charge a string of cells at 2.5 volts per cell. The initial charge voltage shall be between 2.5 and 2.55 volts per cell average. After reaching the regulated voltage, initial charging is continued for the

number of hours indicated in Table C corresponding to the temperature of the coldest **temperature reference cell** in each string. The average cell voltage is determined by dividing the total battery voltage by the number of cells in the string. This voltage should be measured at the charging equipment and recorded at least once a day during the initial charge. Routine measurement of individual cell voltages is not required.

5.11 Continuous initial charging without interruption is preferred in order to save time. However, if the initial charge is interrupted, the battery should be brought back to the same voltage that existed before the interruption and the total cumulative hours of charge shall be that specified in Table C, but not to exceed 250 hours.

5.12 Before stopping the initial charge, record the following on AT&T Technologies Incorporated Company Form SD-97-1285. (See Fig. 3 and 4.)

- (a) Total hours of charge
- (b) Temperature of at least one cell in each tier of each battery string
- (c) Presence or absence of lead-sulfate crystals for each cell.
- (d) Form ID-1285 has been replaced by Form SD-97-1285. It is recommended that Form SD-97-

1285 (Fig. 3 and 4) be used to record initial charge data.

Note: The date of manufacture and the complete serial number is to be recorded on the form (e.g. 840 1-40024).

H. Guard Against Electrolyte Overflow

5.13 If it is necessary to remove electrolyte to prevent overflow, make note of removals on installation records. **Retain** the electrolyte for possible reuse in some of the cell(s) from which it was removed. See Part 10 for records which must be maintained.

I. Equalizing Voltage of Strings Paralleled into Existing Plant

5.14 When adding a new string in parallel to an existing string, the initial charge should be given to the new string only.

5.15 **DANGER: Connections at the battery . straps shall not be made or opened while cells are gassing or for 24 hours thereafter.** When connecting a string in parallel to another string, the final connection should be made through an open switch or circuit breaker. Before closing the switch or circuit breaker, both strings should be approximately the same potential (less than 0.05 volts difference) to prevent arcing. String voltage should

*TABLE C			
TOTAL HOURS OF INITIAL CHARGE AT 2.5 TO 2.55 VOLTS PER CELL			
TIME ON OPEN CIRCUIT*	CELL TEMPERATURE†		
	31 °F (27.22°C) AND ABOVE	65 TO 80°F (18.33 TO 26.66°C)	64°F (17.77°C) AND LESS
Less than 4 months	100 Hours	150 Hours	200 Hours
More than 4 months	150 Hours	200 Hours	250 Hours
* Time on open circuit is to be determined from the "charge by" date on the shipping container. The "charge by" date is that date when the open circuit time will be 6 months. † Cell temperature of the TEMPERATURE REFERENCE CELL.			

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NOTE 1:

**BOLT FACE NUMBERS AND LETTERS
UNDER COLUMN HEADINGS REFER TO
SECTIONS IN INSTALLATION HANDBOOK 18**

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be equalized by either lowering the voltage of the higher string or raising the voltage of the lower-voltage string.

J. Charging Replacement Cells Added to a Battery String

5.16 DANGER: Wells should NOT be handled during boost charge or for 24 hours thereafter. Do not exceed 250 hours total charge at 2.5 to 2.55 volts per cell. Should it become necessary to replace one or more cells in a battery string, the replacement cell(s) shall be charged according to Table C. The replacement cell(s) may be installed in the string and then given an **initial charge** or the replacement cell(s) may be charged separately prior to replacement. In the latter case, following the **initial charge**, the cell(s) should be kept on continuous **float charge** at 2.17 volts per cell until the replacement can be made. The time between discontinuing **float charge** at 2.17 volts per cell and the completion of cell replacement shall not exceed 24 hours.⁴

K. End of Initial Charge

5.17 At the end of the initial charge, record individual cell voltage, as well as charging current in amperes, just before charge is stopped. Also, record the temperature of at least one cell on each tier. No cell voltage at the end of charge 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 10 for records which must be maintained.

6. PROCEDURES 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 plant voltage shall be measured and recorded⁴ weekly; and the maximum interval between all other readings and inspections shall be 1/2 of the time stated in Practice 157-601-701. Any deviation from this requirement shall be with the consent of the customer.

6.02 From initial charge to turnover, batteries shall be maintained on normal float charge. (See Table A.) At least 3 working days after the initial charge of a battery and within a week before

turnover, record individual cell voltages on float. No cell voltage shall be more than 0.05 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, then float the battery for 3 days and recheck the voltages on 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 company local engineering 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 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 company '72 hours after completion of the initial charge.

Note 1: All cells shall be free of lead-sulfate crystals at the time of turnover.⁴

Note 2: The 10-week period referred to starts from the completion date shown on SD-42-20.

Note 3: In some cases, especially part-time attended new installations, batteries are given their appropriate initial charge at the time of receipt but cannot be subsequently kept on continuous 2.17 volt float charge for reasons such as the temporary lack of alarm systems. The batteries are consequently placed on open circuit during the unattended hours. PLACING BATTERIES ON OPEN CIRCUIT AFTER THE INITIAL CHARGE NULLIFIES THE INITIAL CHARGE. Batteries treated in this manner must be given another initial charge and placed on continuous 2.17 volt float charge prior to being turned over to the company.

ALL CELLS SHALL BE FREE OF LEAD-SULFATE CRYSTALS AT THE TIME OF TURNOVER.⁴

6.03 Cell Replacement: 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 company should issue an Engineering Complaint.

6.04 The full-charge **specific gravity** for 15-ampere hour and larger cells should be from **1.200** through **1.220**. 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 for calcium cells.

7. IDENTIFICATION AND ELIMINATION OF LEAD-SULFATE CRYSTALS

A. Identification of Lead-Sulfate Crystals (Plastic Cases)

7.01 After a satisfactory **initial charge** and under normal **float charge** conditions, all cells should be free of lead-sulfate crystals. The absence of lead-sulfate crystals throughout the life of a battery plant indicates that the cells are float charging properly and maintaining a full state of charge. Cells shall be inspected for lead-sulfate crystals to insure that cells are maintaining their charge.

7.02 The disappearance of lead-sulfate crystals or gray coloration occurs from top to bottom during recharge. To insure total absence of lead-sulfate crystals or gray coloration, where possible, inspection for lead-sulfate crystals should be concentrated at the bottom of the positive plate. The flashlight is held close to the jar wall at an angle of approximately 45 degrees. The lead-sulfate crystals will appear as sparkling diamond-like reflecting particles or as gray coloration. Record presence or absence of lead-sulfate crystals on battery maintenance records in place of cell-voltage readings.

7.03 If lead-sulfate crystals appear on all cells in a battery string, the following should be checked as possible causes for the abnormal condition.

- (a) **Rectifier Voltage:** The appearance of lead-sulfate crystals may indicate a low battery float voltage. Check to see if the individual cell float voltage is correct according to Table A. Make appropriate rectifier adjustments if necessary.

(b) **Plant Discharge:** A battery discharge resulting from an interruption of charging, a power failure, testing, or other reasons may produce lead-sulfate crystals on the cell(s). This is normal with all lead-acid cells since lead-sulfate is the material produced when a lead-acid cell is discharged. If the cause of the lead-sulfate crystals is a recent discharge, the crystals will disappear when the cells have been fully recharged on float charge (usually within 2 weeks.) It is mandatory to log all ac input power failure alarms in battery maintenance records.

B. Elimination of Lead-Sulfate Crystals (Plastic Cases)

7.04 After a satisfactory **initial charge** and **float charge**, there should be no lead-sulfate crystals or gray coloration present on the positive plates or straps when examined with a flashlight. Normally, only the positive strap will be accessible for examination. In some arrangements the edges of the positive plates will also be visible. (See Fig. 5.) The visible positive elements shall be black or dark brown and totally free of any diamond-like lead-sulfate crystals or gray coloration. The disappearance of lead-sulfate crystals normally occurs in three distinct phases:

Phase 1: Black and crystalline

Phase 2: Gray and lightly crystalline

Phase 3: Black or dark brown and crystal free.

7.05 The disappearance of lead-sulfate crystals or gray coloration occurs from top to bottom during recharge. To insure total absence of lead-sulfate crystals or gray coloration, where possible, inspection for lead-sulfate crystals should be concentrated at the bottom of the positive plate. The flashlight is held close to the jar wall at an angle of approximately 45 degrees. The lead-sulfate crystals will appear as sparkling diamond-like reflecting particles or as gray coloration. Record presence or absence of lead-sulfate crystals on battery maintenance records in place of cell-voltage readings.

7.06 If lead-sulfate crystals appear on one or a few cells in a string, after the initial charge, or during float charge, the following actions should be taken.

Note: A battery discharge resulting from power failure, testing, or other reasons may

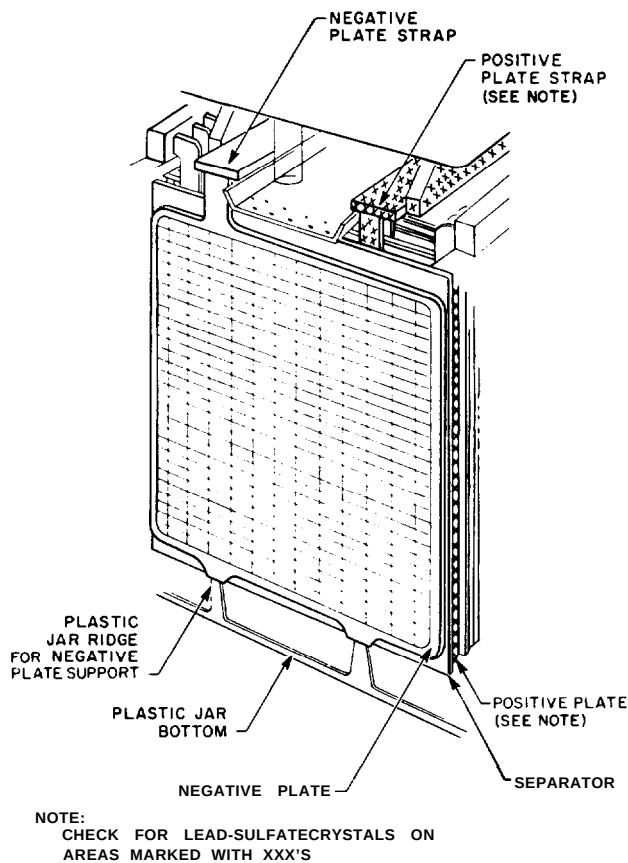


Fig. 5—Typical Rectangular Cell Showing Possible Location of Lead-Sulfate Crystals on Positive Elements

produce lead-sulfate crystals on the cells. This is normal with all lead-acid cells since lead-sulfate is the material produced when a lead-acid cell is discharged. If the cause of the lead-sulfate crystals is a recent discharge, the crystals will disappear when the cells have been fully recharged on float charge (usually within 2 weeks). **It is mandatory to log all ac input power failure alarms in battery maintenance records.**

- (a) **Plant Discharge:** Check to see if a plant discharge has occurred.
- (b) **Cell Shorted:** Measure the cell voltage. If the crystalline cell(s) indicates 2.09 volts or less and the cell visible positive elements are black and heavily crystalline (Phase 1), the cell is shorted

and should be reported in an engineering complaint.

(c) **Cell Temperature Variation:** Measure temperatures of cells in each tier of the string(s) to determine the extremes of temperature differences. Temperature differences of 5°F or more between cells in a string can result in a float charge problem with the warmer cells which would result in the appearance of lead-sulfate crystals. If temperature differences in excess of 5°F are found, appropriate ventilation should be provided to correct the condition.

(d) **Single Cell is Crystalline:** If the problem is **not** attributed to a **shorted cell** [see subparagraph (b)], or to a **cell temperature variation** [see subparagraph (c)], the cell should be boost charged (see Table D), at 2.5 volts with a **single-cell** charger. The boost charge should be continued for at least 24 hours after the lead-sulfate crystals have disappeared. Upon completion of the boost charge, the cell should be allowed to float charge in the string.

- (1) If lead-sulfate crystals **do not** reappear on float charge, no action needs to be taken.
- (2) If lead-sulfate crystals **do** reappear, the cell should be reported to AT&T Technologies Incorporated PPI (Purchased Product Inspection), via a Route G JIM (Job Information Memorandum) for investigation and/or replacement.

Note: The date of manufacture and the complete serial number is to be recorded on the form (e.g. 8401-40024).

(e) **Multiples Cells are Crystalline:** If the problem is **not** attributed to **shorted cells** [see subparagraph (b)], or to a **cell temperature variation** [see subparagraph (c)], it is recommended that the battery string be boost charged at 2.5 to 2.55 volts per cell (see Table D) for a total charge time not to exceed 250 hours for both charges (initial charge and boost charge time combined.) If charging fails to clear the crystals within 250 hours, the cells should be reported to AT&T Technologies Incorporated PPI (Purchased Product Inspection via a Route G JIM (Job Information Memorandum) for investigation and/or replacement.⁴

TABLE D		
BATTERY BOOST CHARGE TIME		
VOLTS PER CELL	TIME IN HOURS BATTERY IS ON BOOST CHARGE	
	MAXIMUM	MINIMUM
2.50	2.7	2.1
2.49	3.3	2.4
2.48	3.6	2.7
2.47	4.2	3.3
2.46	4.8	3.6
2.45	5.7	4.2
2.44	6.6	5.1
2.43	7.5	5.7
2.42	8.7	6.6
2.41	10.2	7.8
2.40	11.7	9.0
2.39	13.5	10.5
2.38	15.6	12.0
2.37	18.0	14.1
2.36	20.7	16.5
2.35	24.0	19.2
2.34	27.6	22.2
2.33	32.1	25.8
2.32*	37.2	29.7
2.31*	43.2	34.5
2.30*	49.2	39.6
2.29*	57.5	46.5
2.28*	67.2	54.0
2.27*	77.4	61.2
2.26*	90.0	72.3
2.25*	104.0	84.0
2.24*	122.0	97.0
2.23*	141.0	113.0
2.22*	162.0	132.0
2.21*	187.0	152.0
2.20*	216.0	176.0
* The lower voltage values (voltages less than 2.33), are for use with low-gravity cells only. The minimum volts per cell shall be 2.33 for high-gravity cells.		

a. LOW-GRAVITY LEAD-ACID CELLS SHIPPED DRY

8.01 ♦The following requirements apply to low-gravity cells that are shipped dry.⁴

(a) The initial charge shall be given within 1 year after shipment.

(b) Between 10 to 18 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.

(c) Just after the precharge leveling but before start of charge, check each cell with any available dc voltmeter to ensure 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.

(d) 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 for 6 hours, if at 25 percent.

(e) Check individual cell voltages.

(f) From initial charge to turnover, follow Part 6.

(g) Prepare records in accordance with Part 10.

9. HIGH-GRAVITY LEAD-ACID CELLS (KS-15754) SHIPPED WET

9.01 ♦The following applies to high-gravity cells that are shipped wet.⁴

(a) The initial charge shall be given within 1-1/2 months after shipment.

(b) Provided there is no evidence of electrolyte spillage, add approved water to bring level up to minimum. Do not remove electrolyte to bring level down to minimum.

(c) With a wire, bent as required, check that the small horizontal vent holes in the vent tube are not clogged with foreign material.

(d) 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.

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

(f) Just before end of charge, check individual cell voltages with a KS-22861, L1, digital multimeter or equivalent having a 0- to 3-volt scale. Do not accept any unit having a cell more than 0.10 volt above or below the average for the five cells of the unit.

(g) 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 ♦1.290 and 1.310.♦

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 subparagraphs (f) and (g).

(h) The initial charge shall be repeated every 3 months until installation, unless the cells are float charged during this period at 2.20 to 2.30 volts per cell for lead-antimony or 2.25 to 2.35 volts per cell for lead-calcium. It is assumed that maintenance after installation will be per Practices ♦157-601-301♦ and 157-601-701.

(i) Record the following data:

- Time and current rate
- Individual cell voltage at the end of charge
- Individual cell specific gravity and temperature of pilot cell after the charge

(j) ♦Prepare records in accordance with Part 10.♦

10. RECORDS (LOW-GRAVITY CELLS)

10.01 It is suggested that records be kept on Form E-2003 (Fig. 6) or Form ♦SD-97-1285 (Fig. 3 and 4).♦ 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.

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

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

10.03 Record conditions of cells between receipt and initial charge.

Example: Dry as shipped, open circuit, float charged 24 hours a day at 2.17 volts, 7 hours daily charge at 2.25 volts, or boost charge every 6 weeks.

10.04 **During Initial Charge of Cells Shipped Dry:** 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.

10.05 **End of Initial Charge:** Just before initial charge is stopped, record ♦total hours of charge, temperature of the temperature reference cell, and the presence or absence of lead-sulfate crystals for each cell.♦

10.06 **From Initial Charge to Turnover:** From initial charge to turnover, record float or maintaining voltage. Record pilot cell voltage and corrected specific gravity weekly.

10.07 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.

[illegible]

Fig. 6-Form E-2003 Storage Battery Record

10.08 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.

10.09 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 company local engineering may be able to improve local conditions.

10.10 **Miscellaneous:** Make note of items of special interest, such as date of manufacture, 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 company, office, town, and state; the manufacturer's name and order number or serial number (see paragraph 1.08); and battery data, that is, number and type of cells should be a part of the initial charge report.

10.11 Two copies of the initial charge report and the final adjustment of electrolyte report, if made, shall be turned over to the local company. It is strongly recommended that one of these copies be filed by the local 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. ♦A copy of the form shall be forwarded to AT&T Technologies, Supplies Marketing, and Engineering Battery Group.4