"LINEAGE* " 2000 ROUND CELL

KS-20472 LEAD-ACID STORAGE BATTERY

DESCRIPTION, INSTALLATION, AND MAINTENANCE

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1. GENERAL

A. Introduction

1.01 This practice includes description, installation, and maintenance instructions for the #LINEAGE 2000 round* cell lead-acid storage battery.

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

(a) To rate the L1S, L2S, L3S, and L4S as replacements for the L1, L2, L3, and L4 cells in paragraph 1.04

(b) To rate the L1, L2, L3, and L4 cells as Mfr Disc. in paragraph 1.04

(c) To add the visual inspection requirement in paragraph 1.05

(d) To add the redesigned post -cover seal in paragraphs 2.03, 2.04, and 2.07.

(e) To add safety admonishments and information to paragraph 3.02

(f) To rate the KS-21527, L1, eyewash kit. KS-21527, L2, eyewash solution as Mfr Disc. and add the KS-21527, L3, eyewash kit, KS-21527, L4, eyewash solution to paragraph 3.03

(g) To add safety admonishments and procedures to paragraph 3.05 through 3.08

(h) To rate GOULD' as a nonsupplier of the KS-20472 LINEAGE 2000 round cell in paragraph 4.01

(i) To update the serial numbers in paragraph 4.01

(j) To add information concerning marking on depolarized cells in paragraph 4.02

(k) To add information concerning electrolyte level lines and electrolyte level requirements in L1, L2, L3, L4, L1S, L2S, L3S, and L4S cells in paragraph 4.03

(1) To add admonishment concerning safety vent funnels in paragraph 4.26

(m) To add Form SD-97-1285 as a replacement for Form ID-1285 in paragraph 5.01

(n) To add requirement that existing and new cells be depolarized before adding cells to a string in paragraph 5.13 and 5.13

(o) To add footnote to Table E concerning checking emergency cells

(p) To update charge procedures and requirements in paragraphs 6.01 through 6.03

(q) To add the KS-22861, L1, digital multimeter to the list of test equipment

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(r) To change the percentage of allowable Manganese impurities in battery water in paragraph 10.13 and Table H

(s) To add admonishments and information concerning connecting, disconnecting, and overtighting battery connections to paragraphs 10.24 to 10.27

(t) To add information concerning safety vent funnels in paragraphs 10.32 to 10.33

(u) To add a Note concerning safety- vents to paragraph 10.33.

1.03 Conventional lead-acid theory and definitions generally apply to the KS-20472 LINEAGE 2000 round cell battery. 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:*** Theory and definitions for conventional lead-acid storage batteries are contained in Practice 157-601-101.

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

> ***Note 3:*** ♦Visual inspection procedures for the KS-20472 LINEAGE 2000 round cells are covered in Practice 157-629-702.

> ***Note 4:*** High-voltage application for the KS-20472 LINEAGE 2000 round cells are covered in Practice 157-629-703.♦

> ***Note 5:*** Description, requirements and procedures for nickel-cadmium engine starting, and control batteries are covered in Practice 157-631-101.

> ***Note 6:*** Description, requirements and procedures for lead-acid engine starting, and control batteries are covered in Practice 157-633-101.

1.04 ***L( ) and L( )S Cells:*** The KS-20472, L1S, L2S, L3S, and L4S, cells replace the KS-20472, L1, L2, L3, and L4, cells, respectively. The KS-20472, L1 through L4, cells are rated Mfr Disc.

1.05 ***L1, L2, L3, and L4 Round Cell Visual Inspection:*** The KS-20472, L1, L2, L3, and L4 round cells require a visual inspection of the positive post seal to espose any signs of possible corrosion. Refer to Practice 157-629-702 for inspection requirements and procedures.

1.06 The KS-20472 LINEAGE 2000 round cell, designed by AT&T Bell Laboratories, substantially increases battery life and greatly improves performance and reliability. It is far more rugged than conventional lead-acid cells and contains many features which make it superior for telecommunication system usage.

B. Recommended Maintenance Intervals

1.07 ♦Recommended maintenance procedures and intervals for the KS-20472 LINEAGE 2000 round cell are found in Table A.♦

2. DESCRIPTION

A. Unique Features of the Round Cell

2.01 ***Plate Design and Composition:*** A major feature of the round cell is the circular grid; the design and pure lead composition results in a slow, uniform growth rate of the positive plate. This insures continuous contact between the positive grid and paste material so that the cell capacity actually increases slightly as the cell ages. The grids are conically shaped and horizontally stacked for maximum strength (Fig. 1). A nen- paste material, tetrabasic lead-sulfate, with rod-like particles which interlock for maximum mechanical stability and increased cycle life, is used in the positive plate.

2.02 ***Jar and Cover Composition:*** The jar and cover are made of a transparent, flame-retardant, rigid, PVC (polyvinyl chloride) material with improved impact and craze resistance which exceeds NEBS (New Equipment Building Systems) general equipment requirements. Refer to Practice 800-610-164. The jar and cover are sealed using a heat-sealing technique. (See Fig. 2.)

2.03 ***Post-Cover Seals:*** A post-cover seal provides a rigid epoxy corrosion restraining sheath on the lead post and is flexibly coupled to the cover to allow stress-free movement of the cell element within the jar (Fig. 3). ♦In order to significantly reduce the possibility of post corrosion, the epoxy-lead interface has been removed from beneath the acid by lowering the electrolyte level in earlier designs and shortening the epoxy sheath in designs made after August 1, 1981. In addition, since January 1984, the positive post has been alloyed with tin, which gives further protection against positive post corrosion. Testing indicates that these post seals will remain free of leakage in excess of 40 years. This combination cf leak-free seals and a flame-retardant, high impact container provides a cell design uniquely suited for both safety and maintenance.

2.04 ***Round Cell Life Expectancy:*** Utilizing the new features of the round cell and based upon estensive laboratory and field tests, it is anticipated that the round cell has a useful life of 30 or more years in continuous float service at ambient temperatures up to 90°F.◀

B. Chemical Composition

2.05 Both the positive and negative grids are made of pure lead. The positive grids are pasted with tetrabasic lead-sulfate and the negative grids are pasted with lead-oxide compound. The electrolyte is the same sulfuric acid (H_2SO_4) normally used in lead-acid batteries with the specific gravity being 1.215 instead of the usual 1.210. For a description of chemical action during charge and discharge, see Practice 157-601-101.

C. Physical Construction

2.06 The round shape provides a mechanically strong structure for the pure lead circular plates. Using a high powered ▶laser,◀ the positive plates are bonded by melting the connecting tabs together at the outer perimeter of the plates (Fig. **1**). The negative plates are joined by pouring a molten lead-antimony alloy down the center hollow core

▶TABLE A◀

RECOMMENDED MAINTENANCE INTERVALS

TASK	INTERVAL	PARAGRAPH
Check battery float voltage (or each visit to unattended sites)	W	10.04
Check individual cells for crystals	4 M	10.05
Check electrolyte temperature	4 M	10.10
Check electrolyte specific gravity	—	10.11
Check electrolyte level	12 M	10.13
Perform water analysis	12 M	10.13
Perform discharge capacity test	—	10.14
Check for cell reversal	—	10.16
Battery boost charge	—	10.25
Check battery connections for corrosion	—	10.26
Clean and inspect battery jar	—	10.30
Check vent funnel tube length	—	10.32
Inspect, clean, or replace safety vent funnel	—	10.33
Remove spilled epoxy from battery jar	—	10.34
Clean and inspect battery racks and stands	—	10.35

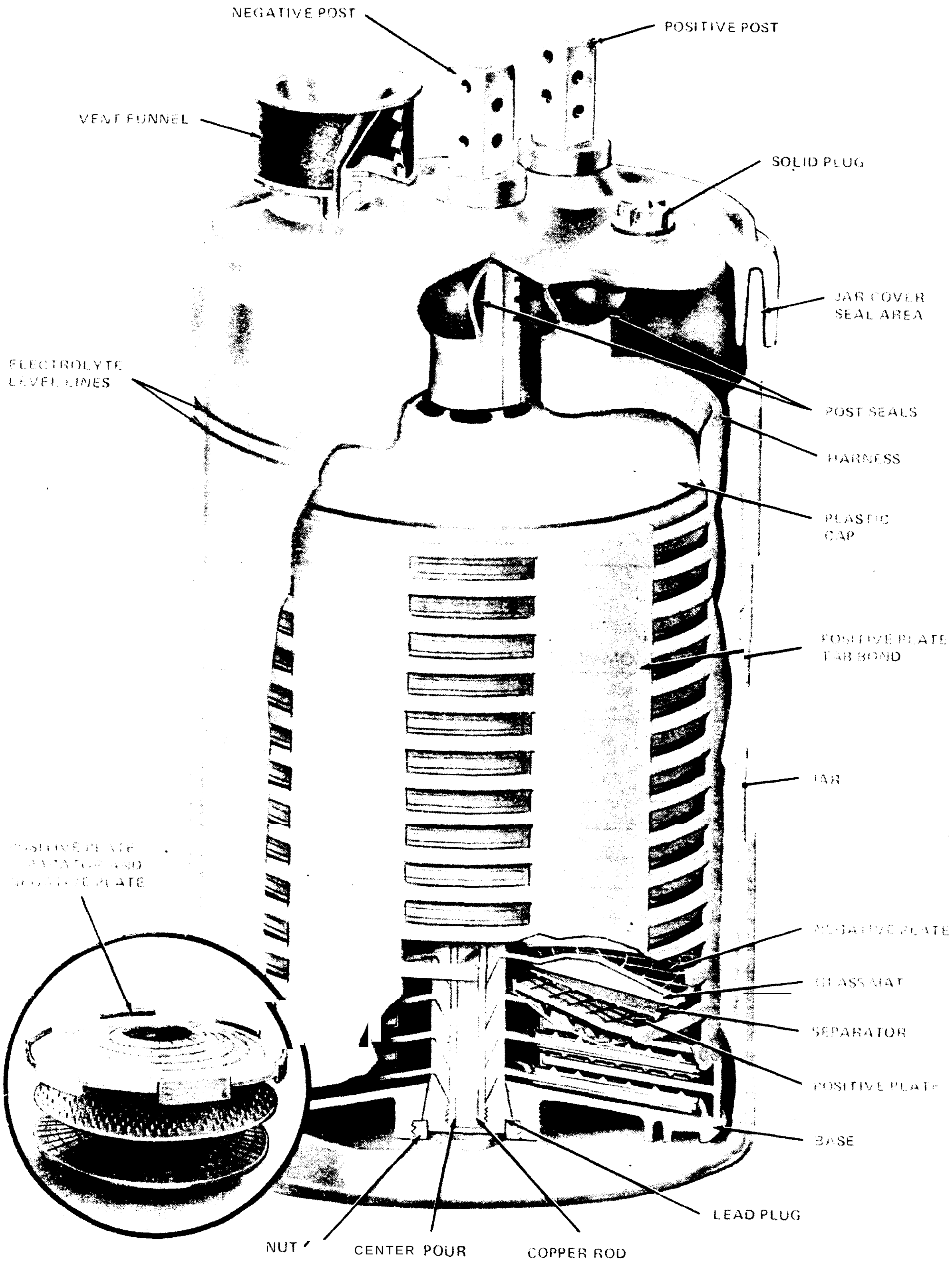

Fig. 1 -New KS-20472 Round Cell (Cutaway View)

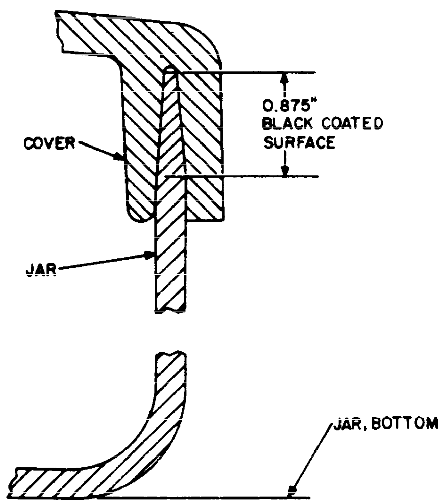

Fig. 2—KS-20472 Round Cell Jar-to-Cover Seal

formed by the mating negative plate huhs. Jar-to-cover sealing is accomplished by coating the joining surfaces with heat absorbing black PVC paint which causes the surfaces to melt and join in a very strong seal when infrared heat is applied (Fig. 2). The primary seal is constructed of an epoxy sleeve cast onto the post. The secondary seal is a rubber sleeve which allows at least ii2 inch of vertical movement within the jar without transmitting any stress to the Cover or *post seals* (Fig. 3).

2.07 ***Round Cell Post Seals:*** The KS-20472, L1S, L2S, L3S, and L4S round cells are essentially identical to the older KS-20472, L1, L2, L3, and L4 round ceils (Mfr Disc.), except that they contain a new post seal design. The new post seal design removes the epoxy-lead interface from the acid and thereby significantly increases the lifetime of the post, seal. Round cells with the new post seal design have black electrolyte level lines similar to the original rqund cell design. On the ***older*** KS-20472, L1, L2, L3, and L4 round cells, new red electrolyte level lines have been added to indicate the iower electrolyte levels which are required to insure that the epoxy interface *has been removed from the acid on the old long* epoxy post seal design.

2.08 ***Round Cell Dimensions and Capacity:*** All covers for KS-20472 round cells are 14-1/2 inches in diameter. The diameter of the round cells at the hair" height point is 13-8/10 inches. The height of the round cells increases as the number of plates in the plate stack increased. The list numbers with their cell capacity and heights are listed in Table B.

> ***#Note:*** KS-20172, L1, L2, L3, and L4 round cells have approximately 5 percent less capacity than that shown in Table B because of lowered electrolyte levels.◆

D. Anticipated Round Cell Life and Comparison to Conventional Cell Life

2.09 The round cell is designed for continuous float service in excess of 30 years in ambient temperatures of 90°F. Elevated temperature reduce the life of all lead-acid cells. The round cell float life is compared to conventional lead-acid cell float charge life in Table C.

E. Advantages of the Round Cells Over Conventional Cells

2.10 Increased safety features are as follows:

(a) Post and cover seals which stop acid electrolyte creepage to the outside of the jar thereby eliminating:

- Personnel exposure to acid leakage and accidental grounding
- Corrosion of posts and intercell connectors
- Possibility of high-resistance connections and associated overheating which causes cell damage and plant outage
- Downtime for periodic cleaning of post and intercell connectors
- Use of nonconducting, nonflammable batter) stand eliminates accidental grounding, fire hazards, and danger to attendant personnel.

(b) Noncrazing or noncracking, flame-resistant jar and stand material which exceeds NEBS flammability requirements

(c) Low maintenance which minimizes exposure of personnel to electrolyte and voltage hazards by eliminating routine measurements of individuai ceil voltage, specific gravity, and temperature, and minimizing the need to add water.

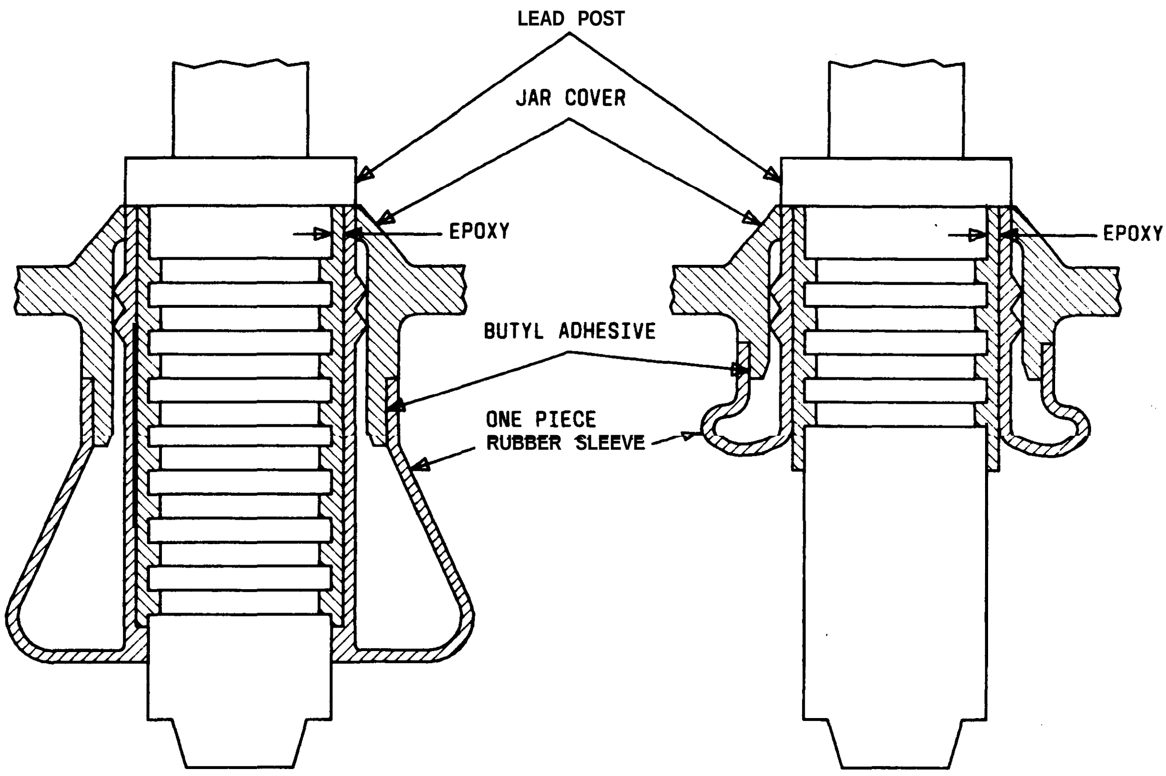

Fig. 3-KS-20472 Round Cell Post Seals

2.11 Additional advantages over the conventional cells are as follows:

(a) Increased life

(b) Increased cell capacity with age

(c) Ease of handling and reduced installation effort

(d) Standardized battery size

(e) Elimination of plate growth problem

(f) Compact cell configuration in a 3-tier modular stand arrangement

(g) Battery and stand designed as a system which provides reduced maintenance in earthquake and hardened sites.

3. SAFETY PRECAUTIONS AND ELECTROLYTE NEUTRALIZATION

A. Electrolyte Corrosion, Burn, and Shock Safety

3.01 *Electrolyte Corrosion and Bodily Protection:* ➧Battery electrolyte is extremely corrosive to most material and human tissue. Therefore, exercise extreme care whenever handling batter] electrolyte or working around batteries.

3.02 ***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, cells 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 bat-***

♦TABLE B♦

KS-20472 ROUND CELL RATED CELL CAPACITY* AND HEIGHT

KS-20472 CELL LIST NUMBER	AMPERE-HOUR CAPACITY * AT 5-HOUR DISCHARGE RATE (77-F or 25'C)	AMPERE-HOUR CAPACITY * AT 8-HOUR DISCHARGE RATE (77-F or 25 C)	ROUND CELL HEIGHT IN INCHES TO TOP OF TERMINAL
List 1 and 1S	1390	1600	26 3/4
List 2 and 2S	750	864	18 7/8
List 3 and 3S	430	488	15 3/8
List 4 and 4S	250	296	13 5/8

* U-20472, L1, L2, L3,and L4 round cells have approximately 5 percent less capacity than that shown in the Table, because of lowered electrolyte levels.

♦TABLE C♦

KS-20472 ROUND CELL LIFE EXPECTANCY VS CONVENTIONAL LEAD-ACID CELL

KS-20472 ROUND CELL LIFE IN YEARS	KS-15544 AND KS-5553 500 SERIES CELLS LIFE IN YEARS	CELL TEMPERATURE °C	CELL TEMPERATURE °F
70	15	25”	77°
35	7	32.22”	90”
20	4	37.77°	100°

tery terminals. Shorting a cell or battery with an 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, and spiash-proof goggles when performing any activity that involves handling of electrolyte, cells containing electrolyte, or maintenance activities requiring exposure to shock or electrolyte contact from these cells.*** Bodily protection from electrolyte burns is provided by wearing full face mask, spiash-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.

Note: The absence of jar cracks and electrolyte leakage greatly reduces fire hazards and electrolyte neutralization problems in the round cell. However, the same precautions must generally be observed that are common with conventional cells.

(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. A flashlight having a plastic or rubber housing should be used.4. Body protection is provided by wearing rubber gloves, rubber apron, full face mask, spiash-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

3.03 ***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 has 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 solution4 is 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 aiiow 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 is 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 1: 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 19'77. 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.

(c) ***Areas Not Equipped with Spark-Arrestor Vents:*** In battery areas containing engine-start batteries ***not*** equipped with spark-arrestor vents, the KS-21527, L3, eyewash kit alone is ***not*** considered satisfactory protection. In such areas, consider replacing existing batteries with batteries equipped with ***spark-arrestor-vents.4***

C. Neutralizing Agents

3.04 ***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. See paragraphs 3.01 and 3.02 for precautions to be observed in cleanup.*** Whenever lead-acid battery electrolyte is spilled it should ***immediately*** be neutralized. The following can be used for electrolyte neutralization purposes:+

(a) ***Soda Solutions:*** Soda solutions are used for general neutraiization of eiectroiyte.

(1) ***Strong Soda Solution:*** 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 approximately 3/4 pint of low-specific gravity electrolyte or 1/2 pint of high-specific gravity electrolyte.

(2) ***Weak Soda Solution;*** 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 35 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

3.05 ***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 a 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 care and 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 because of the possibility of cover seal leaks, post seal leaks, or containers, which would bypass the antiexplosion

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feature. ◆Where static electricity is a probiem, the wearing of ieather-soied shoes is recommended. 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 esplosion hazard exists with properly vented KS-20472 LINEAGE 2000 round cells. Nevertheless, it is prudent to take precautions against ***static sparks*** at all times. ◆***During boost charge (2.3 volts or greater) the atmosphere inside the ceil is expiosrve. 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) cell(s) on boost charge and for 24 hours after completion of boost charge.4***

(c) ***Explosion Precautions:*** Special care and precautions should be used while taking hydrometer or thermometer readings or when instaiiing a new vent in ceiis in service. The vent funnel performs the function of an antiexplosion device in the KS-20472 round cells. These precautions should be used even when working on cells with antiexplosion features because of the remote possibility of cover seal leaks, post leaks, or containers which would bypass the antiexplosion feature. For further information on gas expiosion hazards, see Practice 157-601-101. 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 admonishments and precautions of this practice and local instructions are foiiowed. (See Practice 157-601-101.)

(d) ***Buttery Connections:*** Do ***not*** loosen or remove battery connections whiie cells are gassing or discharging uniess it is absolutely necessary. If removal of connection is necessary during this period, follow procedures specified in subparagraphs (a), (b), and (c), and in paragraphs ◆4.23 through 4.29 and paragraphs 10.23 through 10.29.◆

(e) ***Battery Eiectroiyte Leakage or Spillage:*** Leakage or spillage of battery electrolyte should N O T 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 hazard, will cause corrosion.

(f) ◆***Battery Electrolyte Level:*** ◆Electrolyte level should ***NOT*** be allowed to fall below minimum since this allows the flame-arrestor vents to be bypassed.

(g) ***Electrolyte Overflow:*** Electrolyte overflow from the vent funnel indicates clogged vents, which constitutes an explosion hazard. If this occurs, replace the vent funnel. (See paragraph 10.31.)

(h) ***Buttery Terminal Ends:*** The positive (+) and negative (-) ends of hattery strings shall not he adjacent. Adjacent cells in a string must ***not*** be aiiowed to touch each other.

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

- Use extreme caution when making voltage readings to prevent accidental grounding of the ieads 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 batter) should be removed immediately after each reading is taken.

3.07 ***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 intercell connector near thegrounded end of the***

battery, to discharge the static electricity from your body.

3.08 ***DANGER: Do NOT allow gas vents to become clogged as explosion due to internaipressure may resuit. Such an expiosion may short circuit other cells and lead to a fire.***

4. INSTALLATION PROCEDURES

A. Manufacturer Identification and Serial Numbers

4.01 ***Cell Identification Information Location:*** Each round cell comes with an information label affixed to the top of the cell cover. This label identifies the manufacturer, manufacturing location, and a 9-digit serial number. The g-digit serial number is composed of a 4-digit date of manufacture code (year-month), followed by an AT&T Technologies 5-digit cell identification number. All records and correspondence addressing specific cells should include the manufacturer and the g-digit serial number.

Note 1: All cells manufactured by C&D* between January 1972 and October 1975 have the g-digit serial number stamped on the top of the negative post instead of on the label.

Note 2: All cells manufactured by GOULD between November 1975 and May 1976 have only the 5-digit cell identification appearing on the label. The date of manufacture (the first four digits) for these cells is stamped on the top of the negative post as part of the g-digit serial number.

♦***Note 3:*** GOULD is no ionger a suppiier of the KS-20472 LINEAGE round cell.♦

(a) ***Factory Location Code:*** The cell label contains the name of the manufacturer and a single letter code identifying the manufacturing location as follows:

- R-designates C&D Batteries, Leola, Pennsylvania.
- S-designates GOULD IBD, Fort Smith, Arkansas.

* Trademark of C&D Battery

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

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

(2) ***Serial Number Blocks for Each Manufacturer:*** Serial number blocks are assigned to each suppiier as follows:

- ♦GOULD cells manufactured November 1975 through December 1979:

GOULD 00001 through 19999

- GOULD cells manufactured January 1980 through December 1981:

GOULD 00001 through 49999

- C&D cells manufactured January 1972 through December 1979:

C&D 20000 through 40999

- C&D cells manufactured after January 1, 1980:

C&D 50000 through 99999

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

Example 1: 760110024

Where:

76 = 1976 (Shipment Year)

01 = January (Shipment Month)

10024 = Round Cell No. 10024 shipped by GOULD in January i976.

Example 2: 840655000

Where:

84 = 1984 (Shipment Year)

06 = June (Shipment Month)

55000 = Round cell No. 55000 shipped by C&D in June 1984.◀

B. Marking on Depolarized Cells

4.02 The following markings are used to identify cells which have been depoiarized:

(a) Factory ***Marking:*** The round cells are marked by the manufacturer to indicate that the cell has been depolarized prior to shipping as follows:

(1) ***C&D Round Cells:*** The C&D cells have one of the following marks:

- P-stamped on top of the negative post.
- ꕤ hexagon outside a circle-stamped on top of the negative post.
- An asterisk (*)-stamped on top of the negative post.

(2) ***COULD Round Cells:*** The GOULD cells have one of the following marks:

- An N-stamped on top of the negative post.
- An asterisk (*)—stamped on top of the negative post.

(b) ***Local Marking:*** The round cells are marked in the fields as follows:

(1) An ink stamped P on the side lip of the cell cover or near the level lines; or

(2) The local battery maintenance records should note the addition of depolarizer or platinum or doping, or contain a copy of the form entitled ***Record of KS-20472 Cell Repair.***

Note: All cells manufactured after February 2, 1979, have been depolarized prior to shipping.

C. Electrolyte level lines

4.03 Round cells manufactured prior to May 1981 (L1, L2, L3, and L4 cells) shouid have two sets of level lines (one set red, one set black) on the cell jar. ***On these older cells, the electrolyte level must be maintained between the lower (red) set of level lines.*** Round cells manufactured after August 1981 only have one set of black level lines. These lines are higher than the red lines and slightly lower than the black lines used on the older round cells. The newer cells are designated L1S, L2S, L3S, and L4S. The electrolyte level of the newer cells must be maintained between the black level lines. It is permissible to have cells with these two different electrolyte levels in the same string. Cells manufactured between May 1981 and August 1981 could have either of the two types of level lines previously described. For these cells, the electrolyte level must be maintained as specified.

D. Unpacking Cell and Recording Damage at **Installa**tion

4.04 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 point at which the plastic cap is attached to the negative post, or below the cell plates for more than 20 minutes, the battery is not acceptable for installation because excessive spillage is indicated (Fig. 1). If the electrolyte is l/Z-inch below the low-level marking on the battery jar but above the cap, fill with 1.215 ~0.005 specific gravity electrolyte to the ***low-level murk*** on the battery jar.

(3) ***Electrolyte Level:*** At the time of manufacture, the electrolyte level of each round 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:*** Round 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 Round Cells:*** Before unpacking a cell, examine the shipping container. Record signs of electrolyte spillage or external damage.

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

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

(8) ***After Unpacking Round Cells:*** After unpacking, check electrolyte level of cells immediately after unpacking. Record any action taken in the initial charge report. ➧Also check cells for fractured harnesses. If a fractured harness condition exists, it will be found on one or both sides of the positive post. Figure 4 shows a fractured harness condition in which the harness is fractured on both sides of the positive post. Cells with fractured harnesses are defective and must not be used.4

(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 paragraphs 4.30, 4.31; and 10.11.)

(11) ***Specific Gravity and Temperature Correction:*** The specific gravity of installed and charged cells shall be 2.215 -0.005. See specific gravity readings and temperature corrections in paragraphs 4.30, -1.31, and 10.11.

(12) ***Round 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 1.215 specific gravity acid immediately if available; otherwise, add approved water (see paragraph 10.13) before shipment, as necessary to bring electrolyte level to minimum, and note action taken in report to manufacturer:

E. Cleaning Cell Container and Terminals

4.05 ***Warning: Use only water to clean jars.*** If the jar is dirty when removed from the shipping package, the jar should he cleaned with water and wiped with a cloth dampened in clean water before installing in the rack.

4.06 Cells are shipped with the posts coated with NO-OX-ID A* (regular or special) compound (R-3266). If the posts have come in contact wit h acid due to electrolyte spillage, clean the posts as follows:

(1) Remove the NO-OX-ID A (regular or special) compound.

(2) Neutralize the posts with a weak soda solution.

(3) Wipe the neutralized surfaces with a cloth dampened in clean water. (See paragraph 3.04.)

(4) Recoat the posts and all other exposed lead surfaces, including the round shoulder below the square post with NO-OX-ID A (regular or special) compound.

F. Hoisting Cells Into Place

4.07 ***Warning:*** At rno ***time shall*** the ***cell be tipped more than 25 degrees in order to prevent electrolyte spillage through the vent.*** The cover on round cells is designed with a lip for lifting purposes. Special hoists, similar to the action of ice tongs, are designed specifically for lifting the cell from its shipping crate onto the battery stand. The

* Trademark of Sachem, Inc

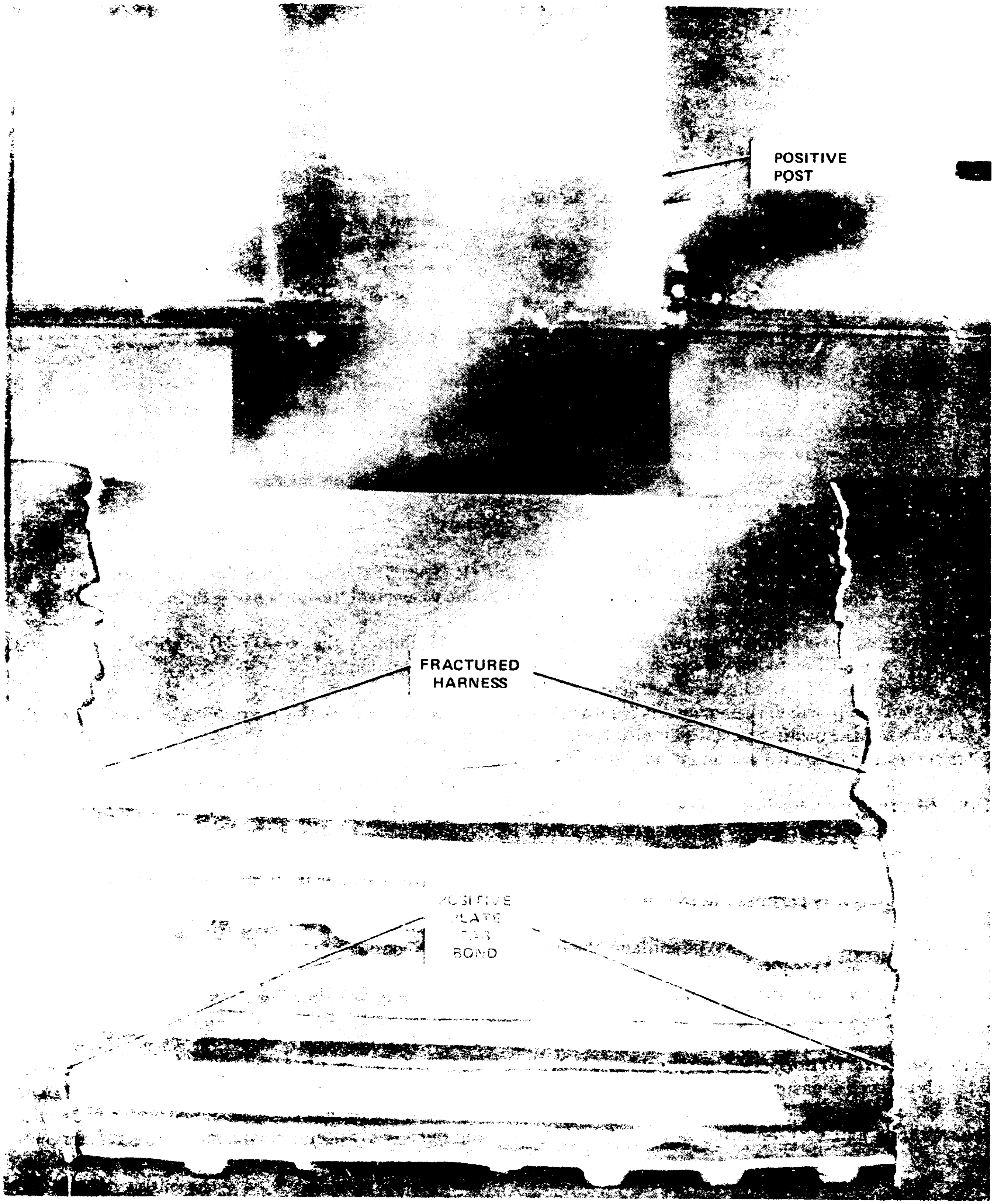


Fig. 4-Fractured Harness on Positive Post of KS-20472 Round Cell

R-4701 hoist is designed specifically for installing round cells on KS-20760 polyester battery stands. 'This is a gantry type hoist and is highly recommended on all new installations where the application allows building the battery stand progressively on a tier-by-tier basis as the cells are being installed. A special lifting clamp, R-4702, is provided with each K-4701 hoist. The lifting clamp lifts the cell by the lip of the jar cover. The R-4701 hoist is not recommended for installing cells on a single row against the wall. An R-4800 eiectricaiiy operated hoist is avaiiabie for installing cells in preassembled stands and on single row arrangements mounted against a wall and for removal of cells on larger jobs. The R-4800 hoist is equipped with the R-4702B lifting clamps.

4.08 ***The R-3448 hoist equipped with an*** R-4702A lifting clamp should be used where cells are being installed on metal stands. An R-4900 shelf jack is available for lifting individual cells out of the battery stand well and for removal of cells on the smaller jobs. An R-4902 battery dolly is avaiia'bie to transport the cells and was designed specifically to complement the round cell battery hoists and stands. The R-4902 mini-gantry is available to load cells onto the R-4902 battery in the storage area.

G. Battery Stands—Soft, Earthquake, and Hardened-Site Installations

> ***Note:*** The National Electrical Code requires a minimum spacing of 4 ***feet*** between stands.

4.09 The admonishments in paragraphs 4.10, 4.11, and 4.12 apply to battery stands.

4.10 ***DANGER: The RTV (room temperature vulcanized) silicone rubber is mildly toxic until cured and should be applied in a well ventilated working area. Trichloroethane (KS-19578, Ll), which may be used to clean spilled epoxy from the stand, is also toxic. See Practices 065-330-120 and 065-330-320.***

4.11 ***Warning: While trichloroethane solvent can be used to remove epoxy from the battery stand, this solvent should never be used on the PVC cell container (jar). To remove spilled epoxy from the jar, allow it to dry and then scrape it off.***

4.12 ***Warning: For hardened-site installations and in earthquake Zone 4, L1 and L1S round cells are limited to stands two tiers high..***

4.13 It is generally recommended that the KS-20472 LINEAGE 2000 round cells be mounted on the KS-20760 polyester battery stand. For soft and earthquake sites already having conventional metal battery stands, the KS-20472, L1S. cells can be used to replace the L508 cells on a one-for-one basis. This aiso appiies for KS-3I4 72, L2S, replacement of L501 cells in standard arrangements. For soft-site application of L3S or L4S cells, it is recommended that the polyester stands be used for space economy.

4.14 When it is necessary to install the stands where the cells will be exposed to heat radiation or direct sunlight or where there may be temperature differences due to the use of muititiered stands, building maintenance should provide shields for the radiators, blinds for the windows, or special ventilation for the muititiered stands to provide less than 5°F temperature variation from the top to the bottom tier-in a string.

4.15 The two parts from which the stand is assembied are shown in Fig. 5. These parts are moulded of a fiberglass reinforced polyester which is a strong, nonconducting plastic. These parts are also acid and fire resistant. A basic module consists of two bases and two backs as shown in Fig. 6 and provides mounting space for two cells. The backs are available in three different heights to accommodate the four cell sizes. The moduie is assembied by inserting the back panels, as shown in Fig. 5, into the base cavity. Panels are cemented into the base cavities for hardened-site and some earthquake applications using RTV silicone rubber. The modules can be further assembled to provide as many mounting positions as needed. (See Fig. 7, 8, and 9.)

4.16 For soft-site installations, the stands can be either free-standing 2-tier, 2-row (Fig. 8), 3-tier, 2-row, or 2-tier, single-row for mounting against a wall. Additional bracing is available for earthquake and hardened-site installations. (See Fig. 9.)

H. Orienting and Spacing Cells in Stands

4.17 When the round cell is positioned on polyester battery stands, the use of mats is not required. ***If** used on metal stands; **nonconducting mats must be used.***

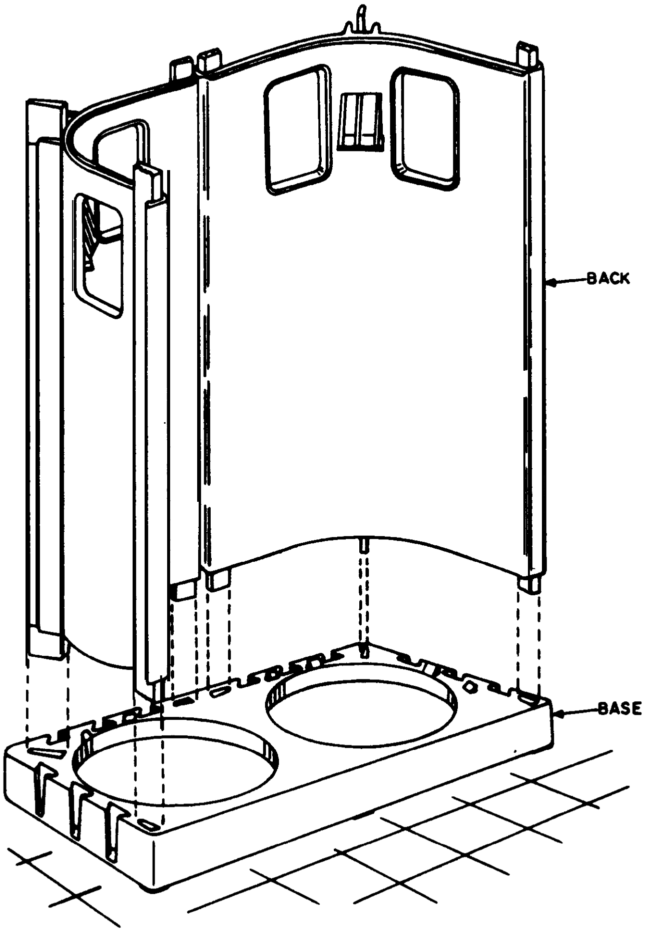


Fig. S-Polyester Battery Stand (Typical) Before Assembly

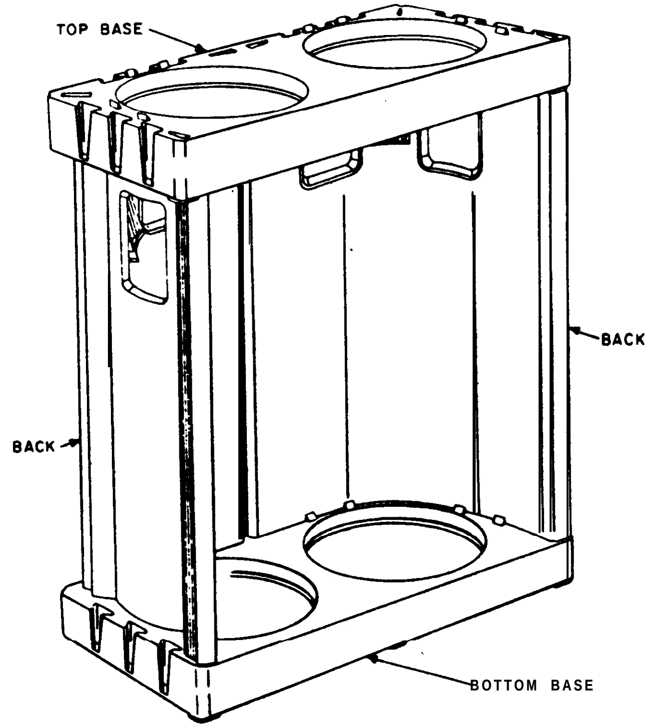


Fig. 6-Basic Module for Four KS-20472 Round Cells

4.18 The space between round cells will normally be governed by the locating wells in the bases of the new polyester battery stands. On metal battery stands, the spacing is governed by the length of the rigid inter-cell connectors. ***In no case should the cell jars be allowed to touch.*** Cell spacing shall be checked after each earthquake or severe shock.

4.19 Spacing between rows on metal stands shall be 3/4-inch minimum. For the polyester stands, the spacing between rows is fixed by the stand design.

4.20 The round cell should never be mixed in the same string with cells of different design. Also, do not mix different size round cells in the same string. Strings of round cells can be used in parallel with strings of rectangular cells.

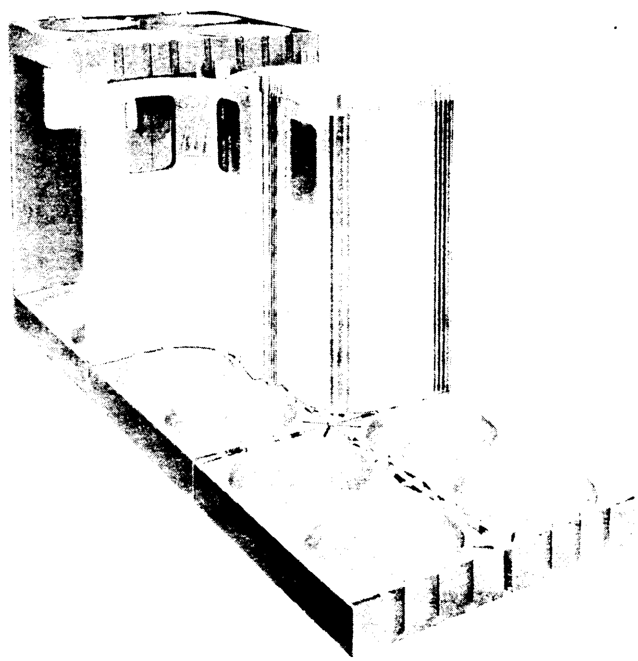


Fig. 7-Polyester Base and Back Assembly

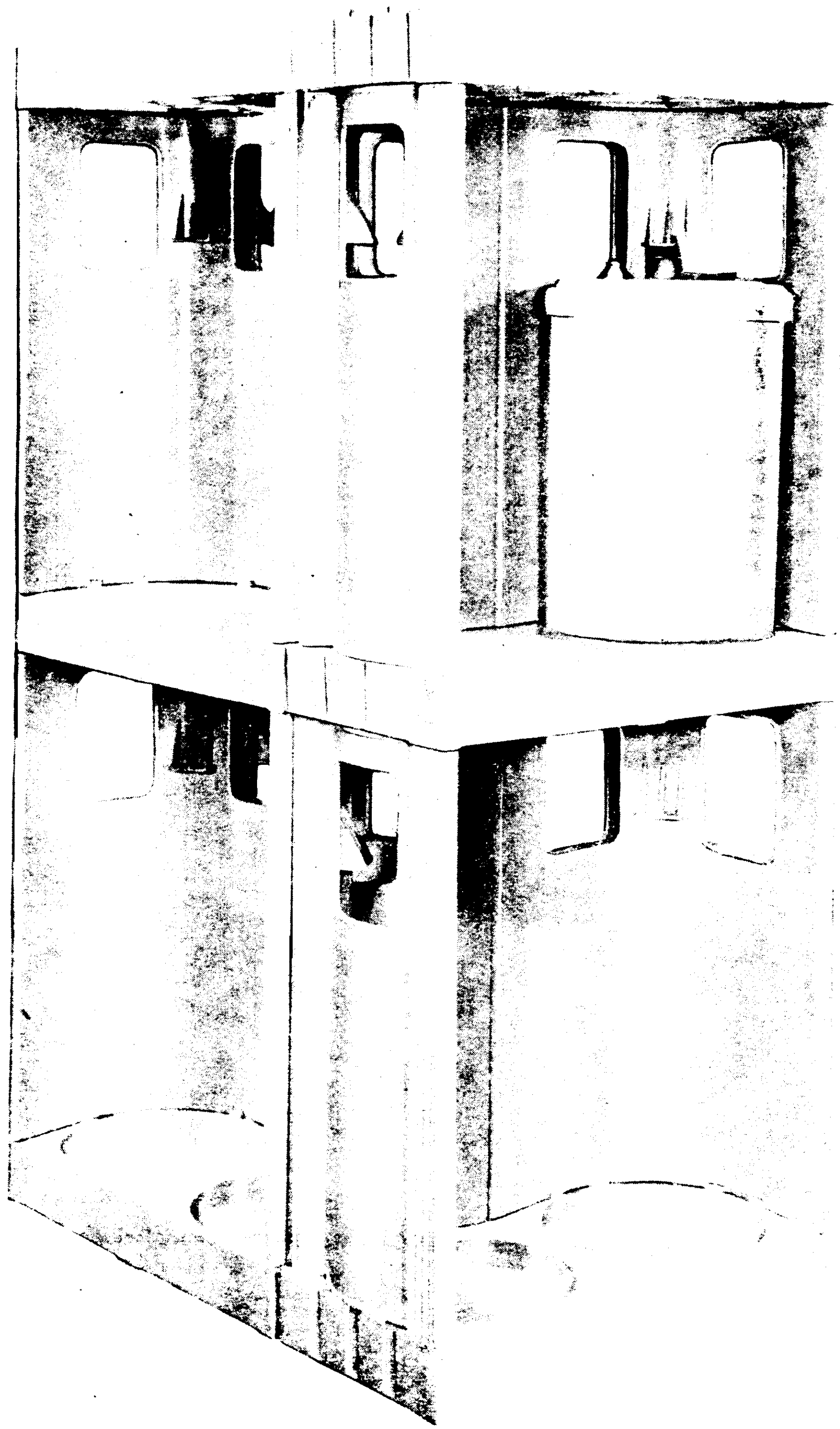


Fig. 8-KS-20472 Round Cells Mounted on Polyester Battery Stand

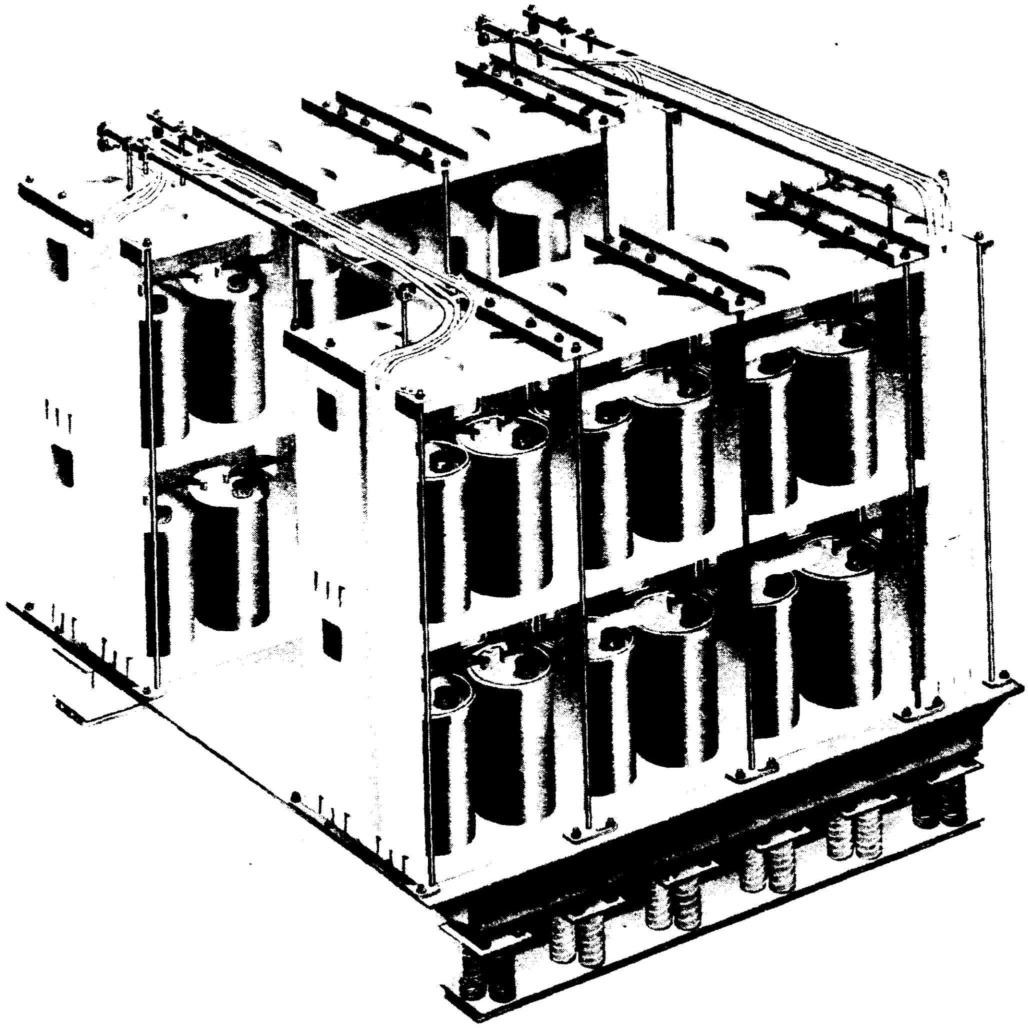
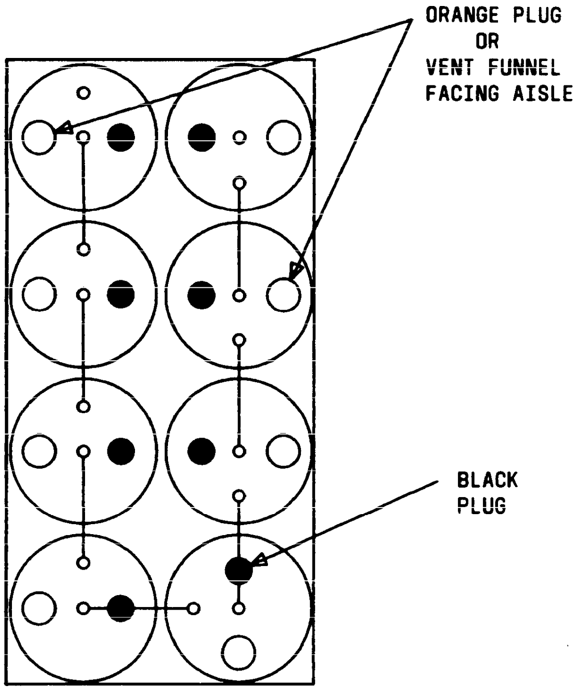


Fig. 9-Polyester Glass Battery Stand With Cells Mounted on Shock Isolation Platform in Hardened Site

4.21 The round cell is shipped with two types of plugs. The black plug is a solid plug and the orange shipping piug is vented. After unpacking, orient the cell on the stand for proper polarity. (See Fig. 10). Once the cells are properly oriented in the stand, insure that the orange plug is in the hole facing the aisle. The black plug is installed in the other hole.



NOTE: ORANGE PLUG MUST BE REMOVED AND VENT FUNNEL INSTALLED BEFORE INITIAL CHARGE

Fig. 1 O-KS-20472 Round Cell **Orientation**

4.22 In some arrangements, the cell orientation will not allow removai of the black plug after the interceii connectors are instaiied (Fig. 10). This is not a problem since removal of this plug is not required or recommended during normal maintenance.

I. Intercell Connectors

4.23 Caution: Use wrenches with insulated handles to p'reveni the possibility of shorting cells. At no time shall battery intercell connectors be filed, scraped, sandpapered, or brushed with a wire brush-this will remove the protective lead coating. Apply NO-OX-ID A (regular or special) compound, using a typewriter brush or similar stiff brush to coat all contact surfaces between the post and interceii connector, if removed for cleaning. Apply compound to threads of connector bolts and to threads of nuts. See paragraphs 10.26 through 10.28 for method of heating and applying NO-OX-ID A (regular or special) compound. Tighten connections using two insulated six-point box wrenches to avoid possible breakage of the lead posts. Verify that all connections have been tightened. After completing connections, wipe off excess compound with a cleaning cloth.

4.24 Do not install the final links which would connect the battery to the power plant until the battery is ready to be charged.

J. Vent Funnel Installation and Disposition of Vent Plugs

4.25 The admonishments in paragraphs 4.26, 4.27, and 4.28 apply to vent funnels.

4.24 ***DANGER: The safety vent funnel tube on all KS-20472 LINEAGE 2000 round cells is lengthened to accommodate the lowered electroiyte level. All older KS-20472, L1, L2, L3, and L4, cells with the iowered eieciroiyie ievei (new red level lines), should have an extension attached to the original tube. All KS-20472, L1S, L2S, L3S, and L4S cells should be equipped with either the extension tube or the new longer safety vent funnel tube. Any vent tube which does not extend below the red level iines (L1, L2, L3, or L4 cell) or new black lines (L1S, L2S, L3S, or L4S cell) must be modified by the installation group. If there are any questions concerning the extension tube, contact the AT&T Technologies QSM (Quality Service Management.)***

4.27 DANGER: Vent funnels with cracks, breaks, or other defects in the bayonet or funnel stem below the gasket, constitute an expiosion hazard during initiai or boost charging above 2.30 volts. Defective funnels must be replaced before charging the cell.

4.28 ***DANGER: Insure that the tip of the funnel is completely submerged below the electrolyte level to eliminate explosion hazard.***

4.29 The vent funnels should be installed before initial charging. Install the vent funnel in place of the orange plug. The orange plug should then be rinsed in water before disposal. At this time, the vent funnels should be carefully examined for defects. If a defect is noted, a new vent funnel should be installed as soon as possible. Cracks in the ceramic or ceramic/funnel bond do not affect its antiexplosion characteristics. Funnels with these latter defects should be replaced when convenient.

K. Hydrometers and Specific Gravity Readings

4.30 ***Warning: Hydrometers used in lead-antimony or lead-calcium cells should not be used in the cells since this would contaminate the electrolyte.*** This admonishment pertains to paragraph 4.31, subparagraphs (a), (b), and (c).

4.31 ***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 and may possibly contain some electrolyte clinging to the wall, goggles should be used in assembly operations to protect the eyes.*** Check and assemble the KS-5499: L1306, hydrometer as follows:

(a) ***Assembling the Hydrometer Syringe:*** Assemble the hydrometer syringe using the following steps.

(1) Remove any mold seam flash 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 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.

(b) ***Flexible Tube Length Determination:*** The Z-shaped extension, supplied in the hydrometer kit, may be used to facilitate hydrometer readings. The flexible tube shall be fitted on the end of the Z-shaped hard rubber tube. The end of the flexible extension tube shall then be cut off so that it extends a minimum of 1/2 inch below the low-level line.

(c) ***Specific Gravity Reading: DANGER: When taking specific gravity readings, the open end of the hydrometer shall be covered while moving it from cell to cell to avoid splashing or throwing the electrolyte.*** The hydrometer tube shall be inserted into the cell through the vent funnel. Then: slowly fill and empty the hydrometer a few times before recording readings in order to wet the float, mix the electrolyte, and equalize the temperature of the hydrometer and the electrolyte. Ensure that the top of the hydrometer float does not touch the stop in the hydrometer bulb since this would cause an erroneous reading. When reading the specific gravity, bring the electrolyte level in the hydrometer to eye level.

L. Temperature Reference Cell Selection

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

5. INITIAL INSTALLATION CHARGE

A. Maximum Time Allowable Until Initial Charge

5.01 The KS-20472 round cells are shipped charged and wet. The maximum time that a charged and wet cell may stand on open circuit shall not exceed 6 months. ***If the storage temperature exceeds 90°F, the open circuit time should not exceed 4 months.*** The 'charge by' date stamped on the shipping container is that date when the cells will be on open circuit for 6 months. If the initial charge cannot be given within 6 months, one of the following procedures should be followed and recorded on Form SD-97-1285.

> ****Note:*** Form ID-1285 has been replaced by Form SD-97-1285. It is recommended that Form SD-97-1285 (Fig. 11 and 12) be used to record initial charge data.◀

SD 97-1285 (7-77)

STORAGE BATTERY REPORT

INSTALLATION ENGINEERING

THIS COPY FOR ______

TOWN AND STATE	OFFICE	JOB ORDER NO	KS LIST	MEASURED END ☐ / ARBITRARY LENGTH ☐	PILOT CELL NO	DATE CELLS SHIPPED	NO OF STRINGS CHARGEO IN PARALLEL	SHEET OF SHEETS

STREET ADDRESS	TELEPHONE COMPANY	SUPPLIERS ORMR No	SUPPLIER: CSD ☐ EXD ☐ GLD ☐ [illegible]	VOLTAGE REGULATION ☐ AUTO ☐	CONNECTED TO WORKING EQUIP. YES ☐ NO ☐	DATE CHARGE STARTED	BATTERY DESIG

INDIVIDUAL MEASUREMENTS — **MEASUREMENTS, START OF INITIAL CHARGE TO TURNOVER**

CELL NO. 17A	ELEC LEVEL 17A (NOTES 1, 2 & 3) AS REC.	CORR ☐ 1/4 INCHES ☐ PINTS	AT END OF INITIAL CHARGE 18B, 18C, OR 18D — DATE: VOLTS IN EXCESS OF 2.00	CRYSTALS (NOTE 4)	TEMP. DEGREES F (NOTE 7)	GRAVITY IN EXCESS OF 1.000 MEAS	GRAVITY CORR	FLOAT AT TURNOVER 18D OR 18F — DATE: VOLTS IN EXCESS OF 2.00	CRYSTALS (NOTE 4)	TEMP DEGREES F (NOTE 7)	INITIAL CHARGE 18B, 18C, OR 18D MEASURED END OR ARBITRARY LENGTH: DATE	HOUR	AMPS OR AVERAGE CELL VOLTAGE (NOTES 5, 6)	PILOT OR TEMPERATURE REFERENCE CELL (NOTE 6): VOLTS IN EXCESS OF 2.00	TEMP DEGREES F	GRAVITY IN EXCESS OF 1.000	MAINTENANCE CHARGE 18D OR 18F FROM INITIAL CHARGE TO TURNOVER: MONTH	DAY	HOUR OR NUMBER OF HOURS	GRAVITY IN EXCESS OF 1.000	TEMP DEGREES F	BATTERY VOLTAGE
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
0																						
											TOTAL HOURS OF CHARGE											
AVERAGE (NOTE 5)								AVERAGE (NOTE 5)														

CHARGING CURRENT ______

DATE OF TURNOVER ______________ 19 ____

REMARKS

MEASUREMENTS BY ______________

APPRCVEO BY ______________ DATE ______

Fig. 11 -Form SD-97- 1285 Storage Battery Report (Front S[illegible]

NOTE 1:
BOLT FACE NUMBERS AND LETTERS UNDER COLUMN HEADINGS REFER TO SECTIONS IN INSTALLATION HANDBOOK 18.

CELL NO.	SERIAL NO.
	17A
1	
2	
3	
4	
5	
6	
7	
8	
9	
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
0	
1	
2	
3	

NOTE 2:
SYMBOLS FOR "AS RECEIVED" COLUMN

SYMBOL 1	SYMBOL 2	
L		INDICATES LEVEL ANYWHERE BETWEEN 1/2 INCH OF PLATE EXPOSURE AND MINIMUM LEVEL. OMIT SECOND SYMBOL.
		OR
M		PREFIX "M" INDICATES MINIM LEVEL REFERENCE
	3	NUMERICAL SUFFIX WHEN USED WITH PREFIX "M" INDICATES HEIGHT IN QUARTERS OF AN INCH ABOVE MINIM LEVEL REFERENCE. /INDICATE TO NEAREST QUARTER OF AN INCH)

EXAMPLES

M	0	MINIMUM LEVEL
M	7	1-3/4 INCHES ABOVE MINIMUM LEVEL

NOTE 3:
SYMBOLS FOR "CORRECTED" COLUMN

IN THE APPROPRIATE BOX, INDICATE WITH AN "X", THE UNIT OF MEASUREMENT USED.

SYMBOL 1	SYMBOL 2	SYMBOL 3	
W			FIRST SYMBOL - ALL CELLS YATER ADDED
"			ELECTROLYTE REMOVED
"			ELECTROLYTE ADDED
	3	1	SECOND AND THIRD SYMBOL FOR HARO RUBBER CELLS SECOND AND THIRD SYMBOL INDICATES PINTS IF LESS THAN (10 PINTS. SHOW A ZERO (0) AS SECOND SYMBOL.
	0	3	SECOND AND THIRD SYMBOL FOR PLASTIC CELLS SECOND AND THIRD SYMBOL INDICATES NUMBER OF QUARTERS Of AN INCH. IF LESS THAN 10 QUARTERS (2-1/2 INCHES). SHOW A ZERO (0) AS SECOND SYMBOL

EXAMPLES

W	1	9	WITH 1/4 INCHES AS THE UNIT OF MEASUREMENT: 4-3/4 INCHES OF YATER ADDED
R	0	7	1-3/4 INCHES OF ELECTROLYTE REMOVED
W	2	7	WITH PINTS AS THE UNIT OF MEASUREMENT: 27 PINTS OF YATER AWED
R	0	7	7 PINTS OF ELECTROLYTE REMOVED

NOTE 4

SYMBOLS FOR "CRYSTALS" COLUMN.

THE LETTERS "N" (FOR NO) AND "Y" (FOR YES) SHOULD BE USED FOR RECORDING THE ABSENCE OR PRESENCE OF CRYSTALS.

THIS COLUMN IS USED ONLY WHEN KS-20472 CYLINDRICAL CELLS ARE INVOLVED.

NOTE 5

"AVERAGE" CELL VOLTAGE IS DETERMINED BY DIVIDING THE BATTERY VOLTAGE BY THE NUMBER OF CELLS IN THE STRING.

NOTE 6

SELECT A PILOT CELL MN USING THE MEASURED END METHOD AND A TEMPERATURE REFERENCE CELL WHEN USING THE ARBITRARY LENGTH METHOD.

NOTE

"INDIVIDUAL MEASUREMENTS - TEMPERATURE"

RECORD THE TEMPERATURE O f AT LEAST ONE CELL PER TIER. ALL CELL TEMPERATURES NEED NOT BE RECORDED.

NOTE 8

"AMPS OR AVERAGE CELL VOLTAGE" COLUMN

DURING CHARGE. RECORO AMPS WHEN USING THE MEASURED END METHOD AND AVERAGE CELL VOLTAGE WHEN USING THE ARBITRARY LENGTH METHOD.

WHEN THE ARBITRARY LENGTH METHOD IS USED, RECORD BOTH AMPS AND BATTERY VOLTAGE AT THE END OF CHARGE

Fig. 12-Form SD-97-1285 Storage Battery Report (Back Side)

(a) Maintain the battery on continuous fioat charge operation until the normal initial charge can be administered and thereafter maintain on float as specified in paragraphs 6.01 and 6.02.

(b) Charge at 2.17 to 2.20 volts per cell, 8 hours a day, 5 days a week until the normal initial charge can be administered.

(c) ***DANGER: For maximum safety, cells should NOT be handled during boost charge or for 24 hours thereafter.*** Give a boost charge at 2.5 to 2.55 volts for 8 hours every 6 to 8 weeks until the normal initial charge can be administered.

B. Initial Charge

5.02 An initial charge should be given to all KS-20472 round cells 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 just prior to initial charge, from the ***temperature reference cell(s)*** as described in paragraph 4.32. Cell temperatures higher than 110°F are not permissible during initial charge.

C. Procedure for Initial Charge

5.03 ***DANGER: For maximum safety, connections at the battery should not be made or opened and cells should not be handled during boost charge or for 24 hours thereafter. This admonishment pertains to paragraphs 5.04 and*** 5.05.

5.04 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 50 cells for initial charge. No more than three groups should be connected in paral-!e!.

5.05 The initial charge voltage shall be between 2.5 and 2.55 volts per cell average. Charging is continued for the number of hours indicated in Table D corresponding to the temperature of the coldest temperature reference cell in each string. Cell temperature is determined by selecting a ***temperature reference cell*** as determined in paragraph 3.32 and 5.02.

5.06 When using a portable charger such as ITE-5965A, where the maximum charging current is greater than 10 amperes per string, the time determined from Table D can be considered the total time on charge. If an additional batter-l- string is charged in parallel with such a charger, an additional 24 hours must be added to the time determined in Table D. It is recommended that not more than two strings be charged in parallel with this charger. After 20 minutes of initial charge, measure each cell's voltage and the temperature of one cell in each tier. The charge may then be continued and completed unattended if all the cells are above 2.06 volts and 90 percent are above 2.10 volts. However, if the 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 D, but not to exceed 250 hours.

> ***Note:*** While on initial charge, the electrolyte level will rise substantially. ***Do not remove electrolyte.*** The electrolyte level in round cells is preadjusted by the manufacturer to be between the level lines when the cells are floated at 2.17 volts for an extended period of time.

D. Requirements at End of Initial Charge Identification of Lead-Sulfate Crystals

5.07 After a satisfactory initial charge, there should be no lead-sulfate crystals or gray coloration present on the vertical positive plate columns when examined with a flashlight. The vertical columns 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: Grey and lightly crystalline

Phase 3: Black or dark brown and crystal free.

The disappearance of lead-sulfate crystals or gray coloration occurs from top to bottom during initial charge. To insure total absence of lead-sulfate crystais or grey coloration, inspection for crystals should be concentrated at the bottom of the positive plate vertical columns. Lead-sulfate crystals can readily be

TABLE D

TOTAL HOURS OF INITIAL CHARGE AT 2.5 TO 2.55 VOLTS PER CELL

TIME ON OPEN CIRCUIT*	CELL TEMPERATURE †		
	81 °F (27.22%) 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.

seen on the positive plate vertical columns with the aid of a flashlight. 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 as shown in Fig. 13, or as a gray coloration.

5.08 Cells which are not free of lead-sulfate crystals after the initial charge may be shorted. If some cells are still crystalline after initial charge, it is recommended that the battery string be continued on boost charge at 2.5 to 2.55 volts for a total charge time not to exceed 250 hours for both charges (initial and boost charge combined). If charging fails to clear the lead-sulfate crystals within 250 hours, the cells should be reported to #AT&T Technologies' PPI (Purchased Product Inspection) via a Route G JIM (Job Information Memorandum) for investigation and/or replacement.

5.09 Before stopping the initial charge, record the following:

(a) Total hours of charge

(b) Temperature of the temperature reference cell in each tier of each battery string

(c) Presence or absence of lead-sulfate crystals for each cell.

5.10 Adjust the charging voltage to 2.17 volts per cell float voltage.

E. Equalizing Voltage of Strings Paralleled Into Existing Plant

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

5.12 ***DANGER: Connections at the battery 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 away from the batteries. Before closing the switch or circuit breaker, both strings should be approximately the same potential (less than 0.05 volt difference) to prevent arcing. String voltage should be equalized by either lowering the voltage of the higher string or raising the voltage of the lower-voltage string.

Fig. 13—Lead-Sulfate Crystals on Positive Plate Column

F. Charging Cells Added to a String

5.13 ***Caution: The KS-20472 round cells should never be mixed in the same string with cells of different design. Also, do not mix different size KS-20472 round cells in the same string.*** New round cells may be intermixed directly into an existing string of older round cells (of the same capacity) when necessary for replacement purposes, if the original cells have been treated with platinum depolarizer. (All new round cells are factory treated with platinum depolarizer.)

5.14 If the original cells have not been factory or field depolarized, platinum depolarizer solution should be added.

5.15 Where a multiple string installation is involved, it is generally recommended that cells be segregated into complete strings, by manufacturing vintage whenever possible. This will minimize the administrative efforts associated with maintenance and record keeping of mixed strings.

5.16 ***DANGER: For maximum safety, cells 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 D. 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 at 2.17 volts per cell until the replacement can be made. The time between discontinuing the float charge at 2.17 volts per cell and the completion of replacement shall not exceed 24 hours.4

6. FROM INITIAL CHARGE TO TURNOVER

A. Float Procedures and Requirements

6.01 ***After End of Initial Charge:*** ◆***DANGER: For maximum safety, cells should NOT be handled during boost charge or for 24 hours thereafter.4*** At the end of initial charge, the battery should be placed on continuous uninterrupted float charge at 2.17 volts per cell. ◆The battery should not be left on open circuit for more than 24 hours. Open circuit time in excess of 24 hours must be recorded on Form SD-9'7-1285, Fig. 11 and 12. A battery that is left on open circuit for more than 24 hours after initial charge may develop lead-sulfate crystals. A battery that is left on open circuit for more than 24 hours after initial charge and/or developes lead-sulfate crystals must be boost charged at 2.5 volts per cell for at least 8 hours or until crystal free prior to being returned to continuous float: Record boost charge conditions on Form SD-97-1285.

6.02 ***From Initial Charge to Turnover:*** From initial charge to turnover, battery plant voltage shall be maintained at 2.17 ±0.01 volts per cell average. After at least 7 days on float and within a week before turnover, inspect all cells and record the presence or absence of lead-sulfate crystals. Measure cell voltage on crystalline cells. If any cell(s) is heavily crystalline (see paragraph 5.07, phase 1) ***and*** reads 2.09 volts or less, it is shorted and should be reported to AT&T Technology PPI via a Route G JIM for replacement. If any cell(s) is crystalline and voltage measurement reads greater than 2.09 volts, the cell ◆should be given an individual boost charge to clear the crystals.4

6.03 ***Electrolyte Levels:*** Electrolyte levels should not be adjusted until the cells have been on continuous float charge for at least 2 weeks. If levels are low (more than 1/4-inch below low-level mark) after this time, they should be adjusted by adding 1.215 specific gravity sulfuric acid which meets requirements of Federal Specification 0-S-801B. If levels are less than 1/4-inch below the low-level mark, approved water may be added. If the electrolyte levels are high, they should be adjusted by removing electrolyte. Once electrolyte has been properly adjusted, all further adjustments should be made by adding approved water only.4

B. Final Connection of Cell Groups

6.04 ***DANGER: For maximum safety, cells should not be handled during boost charge or for 24 hours thereafter.*** In those cases where cells were divided into smaller groupings for initial charge, adjust charge voltage to 2.17 volts per cell, float charge and hold for 24 hours. Disconnect cell groupings and reconnect into final configuration. Place on continuous float charge at 2.17 volts per cell within 24 hours of open circuit.

7. RECORDS UNTIL TURNOVER

7.01 It is suggested that records be kept on AT&T Technology Form SD-97-1285.

> ***Note:*** Form ID-1285 is replaced by Form SD-97-1285 (Fig. 11 and 12).

7.02 Record serial numbers of all cells and their positions in the battery string.

7.03 Record all changes made in the electrolyte level of 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.

7.04 Record conditions of cells between receipt and initiai charge.

> ***Example:*** Open circuit, floated 24 hours a day at 2.17 volts, 7 hours daily charge at 2.25 volts, or boost charge every 6 weeks.

7.05 Record the following on Form SD-97-1285 (Fig. ii and 12) before starting initiai charge:

(a) Temperature of temperature reference cells

(b) Type of rectifier used to charge cells

(c) Number of strings being charged on rectifier

(d) Measured charging current and voltage used to charge batteries.

> ***Note:*** Temperature readings should be to the nearest degree; for example, 77°F.

7.06 After 20 minutes of initial charge, measure and record individual cell voltage on Form SD-97-1285.

7.07 At the end of initial charge record the temperature of at least one cell in each tier and the presence or absence of lead-sulfate crystals on each cell.

7.08 From initiai charge to turnover, record the condition of the cells. This includes any time on open circuit in excess of 24 hours, significant variation of float voltage outside 2.16 and 2.18 volts per cell float average, and any boost charges applied.

7.09 Within the week prior to turnover, record the presence or absence of lead-sulfate crystals on each cell on Form SD-97-1285.

7.10 Record readings from low-voltage test procedures on Form SD-97-1285.

7.11 ***Two copies of the initial charge report shall be turned over to local engineering.*** One of these copies should be filed by local engineering as a permanent record to be maintained during the life of the battery.

8. APPARATUS

8.01 ***List of Tools, Materials, and Test Equipment:*** The following tools, materiais, and test equipment are used in this practice:

TOOLS	DESCRIPTION
◆R-2628	Bore Brush
—	Flashlight, regular or angular, having plastic or rubber housing
—	3-inch and 6-inch Wrench Extension
R-4810	Six-Point Single-end Box Wrenches having handles insuiated with two coatings of a high dielectric vinyl plastic.◆
R-2969	Typewriter Brush
R-4701*	Hoist
◆R-4702A*	Ciamp, Battery Lifting
R-4786	Gantry Extension (Required for 3-tier arrangements)
R-4800*	Hoist4
R-4900*	Shelf Jack
R-4901	Mini-gantry
R-4902*	Battery Dolly
KS-21527,L3	Eyewash Kit

*Required only for installation.

TOOLS	DESCRIPTION
KS-21527,L4	Eyewash Solution

MATERIALS	DESCRIPTION
—	Agriculture or Industriai Lime (may be purchased locally)
—	♦Alcohol—Methyl USP grade♦
—	Container (glass, glazed porcelain, plastic rubber, earthenware or lead-for handiing electrolyte or waterj
—	Glass or Plastic Funnel (obtained locally)
—	Household Ammonia
—	&Neoprene Gloves♦
—	Overshoes, Rubber (obtain locally)
—	@Baking Soda (sodium bicarbonate)
—	Washing Soda (sal soda)♦
—	water, distilled or approved for use in storage cells (see paragraph 10.13)
—	Wiper Paper, SCOTT* No. 58 or 59
—	Sandpaper
R-3034	Gloves, Acid Resistant (for heavy duty)
R-3043	Apron, Acid Proof
R-3266	NO-OX-ID A (Regular or Special) Compound (for batteries)
♦R-4365	Hat, Safety Hard
R-4501	Goggles, Chemical Safety
R-4517	Coverall Chemical, Disposable♦
KS-14666	Cloth

* Trademark of SCOTT Paper Company.

TEST EQUIPMENT	DESCRIPTION
—	KS-5499, L1306, Hydrometer (for low-gravity cells)
—	KS-5499, L1353, Thermometer
—	♦KS-22861, L1, Digital Multimeter♦

9. RULES FOR GOOD BATTERY MAINTENANCE

9.01 The following rules should be adhered to:

(a) Maintenance operations which require direct physical contact with cells, connectors, etc., should not be performed without first isolating the string if the plant fioat voitage is greater than 160 volts. Review and observe the safety admonishments and precautions in Part 3.

(b) Maintain correct battery plant float charge voltage values (2.17 ±0.01 volts per cell).

(c) Maintain electrolyte level between the high- and low-level markings on the jar by the addition of approved water.

(d) Avoid excessively high electrolyte temperatures.

(e) Keep battery clean.

(f) Avoid using an open flame near batteries.

(g) Avoid creating sparks, including those from static electricity, near batteries.

(h) Maintain complete and accurate battery records.

10. REQUIREMENTS AND MAINTENANCE AFTER INSTALLATION

A. Battery Records and Readings

10.01 Maintain complete battery records for each string of cells. Engineering complaints on batteries cannot be accurately analyzed and satisfactorily settled unless they are accompanied by records which provide a thorough history of the cells in question.

(a) Record dates of all battery maintenance routines.

(b) Record temperature of 'temperature reference cells' whenever battery maintenance routines are performed. It is not necessary to take the temperature of each individual cell. The temperature of one cell on each tier is sufficient.

(c) Although existing forms are not consistent with the new maintenance routines for round cells, it is recommended that Form E-2003 (Fig. 14) or Form E-3593 (Fig. 15) continue to be used as suggested below until new forms become available. The 'cell volts' columns on these forms should be used to show the results of visual inspection for lead-sulfate crystals. The letter N (for no) should be used to record the absence of lead-sulfate crystals, and the letter Y (for yes) should be used to record the presence of crystals.

Note: Any observed irregularities, such as prolonged discharge (greater than 30 minutes) or excessive amounts of water required (more than once a year), should be noted.

B. Battery Maintenance on Float

10.02 Maintenance routines for the round cells are significantly simplified in comparison to rectangular cells. Field experience shows that the presence or absence of lead-sulfate crystals is a much more accurate indicator of cell condition than voltage and specific gravity readings and allows for easy inspection of cells.

10.03 For detailed maintenance requirements, see Table E. ▶See Table A for recommended maintenance intervals. For details of float operation, see Practice 157-601-301. This practice is applicable for general requirements only.◀

C. Battery Float Voltage

10.04 ***It is extremely important to maintain a battery plant float voltage of 2.17 ± 0.01 volts per cell average.*** The ▶KS-22861, L1, digital multimeter◀ is suitable for battery voltage readings. Emphasis must be placed upon the necessity for periodic checks for voltmeter accuracy and calibration. Extreme caution should be exercised when making voltage readings to prevent accidental grounding of leads during the test operations. Connections at the meter should be secure and free of any possibility of touching or becoming grounded. In no case should connections at the meter end be removed without first disconnecting the test leads from the battery. Test lead connections at the battery should be removed immediately after each reading is taken.

D. Lead-Sulfate Crystals

10.05 Cells shall be inspected for lead-sulfate crystals as described in paragraph 5.07. Under normal float conditions, cells should be free of lead-sulfate crystals.

10.06 If lead-sulfate crystals appear within a 10-week period of normal float operation after turnover of the battery plant, the defective cells will be replaced and reinstalled on a nonbillable basis. Such an unsatisfactory float condition should be reported using the established Engineering Complaint procedures.

10.07 Throughout the life of a battery plant, the absence of lead-sulfate crystals indicates that the cells are floating properly and maintaining a full state of charge. ▶The presence of lead-sulfate crystals is not normally an indication that the battery or cell is incapable of providing adequate capacity and, therefore, corrective action for crystalline cell(s) is not an urgent item. A crystalline cell will suffer an immediate loss of approximately 5 percent of its rated capacity. Any further decay in capacity will depend upon the precise cause for the crystalline condition. The best way to assess the ability of a crystalline cell to deliver capacity is to make a specific gravity reading. If the specific gravity is in the normal range of 1.210 to 1.220, then the deration in cell capacity will be only approximately 5 percent. Concern for the ability of a crystalline cell to deliver reasonable capacity should begin when the specific gravity decreases below 1.200.◀

PRINTED IN U.S.A.
FORM E-2003

SHEET NO. ______

STORAGE BATTERY RECORD

INDIVIDUAL CELL READINGS

READINGS TAKEN BY ____________________

APROVED BY ____________________

CITY AND STATE ____________________

OFFICE ____________________

DATE ____________________ 19 ______

CELL NO.	BEFORE CHARGE			CELLS VOLTS	AFTER CHARGE		
	HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F		HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F
BAT.							
TIME							

CELL NO.	BEFORE CHARGE			CELLS VOLTS	AFTER CHARGE		
	HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F		HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F
BAT.							
TIME							

BAT. NO.		PILOT CELL NO.			
TIME	AMP. INTO BAT.	HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F	CELL VOLTS

BAT. NO.		PILOT CELL NO.			
TIME	AMP. INTO BAT.	HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F	CELL VOLTS

BAT. NO.		PILOT CELL NO.			
TIME	AMP. INTO BAT.	HYDROMETER READING	TEMP. ELEC. F	SP. GR. CORRECTED TO F	CELL VOLTS

Fig. 14—Form E-2003 Storage Battery Record

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FORM E-3593 (11-49)

SHEET NO.__________

STORAGE BATTERY RECORDS – INDIVIDUAL CELL VOLTAGES

OFFICE, CITY & STATE____________________ READINGS FROM____________ TO____________

READ. BY							READ. BY						
APP. BY							APP. BY						
BAT.							BAT.						
DATE							DATE						
TIME							TIME						
CELL NO	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	CELL NO	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS

REMARKS

Fig. 15—Form E-3593 Storage Battery Record—Individual Cell Voltages

TABLE E

KS-20472 ROUND CELL BATTERY MAINTENANCE REQUIREMENTS

DESCRIPTION OF OPERATION	REQUIREMENTS
Battery float voltage measurement*	2.17 ±0.01 volts per cell (average)
Inspect individual cells for lead-sulfate crystals	No lead-sulfate crystals
Measure temperature of one cell per tier	Temperature does not vary more than 5°F
Check electrolyte level	Electrolyte level between high and low level marks. (Red lines on L1, L2, L3, and L4 cells; black lines on L1S, L2S, L3S, and L4S cells)
Inspect and clean	Per local requirements (if necessary)

* At unattended locations, battery float voltage readings should be made and recorded upon each office visit if the interval between visits exceeds 1 week. Includes all emergency cells contained in the battery string being checked.

10.08 If lead-sulfate crystals appear on all cells in a 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 plant float voltage. Check to see if the battery plant float voltage is 2.17 ±0.01 volts per cell. Make appropriate rectifier adjustments if necessary.

(b) ***Plant Discharge:*** A battery discharge resulting from a power failure or other reasons may 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 (usually within 2 weeks). As the cells recharge, the disappearance of lead-sulfate crystals will occur from top to bottom in the cell stack. Therefore, inspection for lead-sulfate crystals should be concentrated along the bottom of the positive plate vertical columns. Check plant records to determine if a discharge has occurred. ***It is mandatory to log all AC input power failure alarms in battery maintenance records.*** Another method of determining if a plant discharge has occurred, is to measure cell specific gravities. The nominal specific gravity of KS-20472 round cells is 1.215 ±0.005. Readings of 1.200 or less would be a clear indication that a plant discharge has occurred.

(c) ◆If the presence of lead-sulfate crystals on all cells in a string is not attributable to a plant discharge or improper rectifier voltage, the condition should be reported on an Engineering Complaint.◆

10.09 If lead-sulfate crystals appear on one or a few cells in a string, the following actions should be taken.

(a) Check to see if a plant discharge has occurred. (See paragraph 10.08.)

(b) Measure the cell voltage. If the crystalline cell(s) reads 2.09 volts or less and the cell is heavily crystalline (see paragraph 5.07, phase 1), the cell is shorted and should be reported in an Engineering Complaint.

(c) Measure temperatures of cells in each tier of the string to determine the extremes of temperature differences. Temperature differences of 5°F or more between cells in a string can result in a float 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) ***DANGER: For maximum safety, cells should not be handled during boost charge or 24 hours thereafter.*** If the problem is not attributable to a shorted cell [subparagraph (b)] or temperature variations [subparagraph (c)], the cell(s) should be boost charged at 2.5 volts with a single cell charger. The boost charge should continue for at least 24 hours after the lead-sulfate crystals have disappeared. Upon completion of the boost charge, allow the cell to float in the string. After returning the cell to float, it is not unusual for the cell voltage to be temporarily low (approximately 2.09 volts). The cell voltage should increase over a period of weeks. If lead-sulfate crystals do not reappear on float, no action is necessary. If lead-sulfate crystals reappear, the cell(s) should be reported as an Engineering Complaint. Copies of the battery records should accompany the complaint.

E. Temperature

10.10 The round cell, like all lead-acid cells, is affected by the temperature of its electrolyte. Therefore, observe the following precautions when working with the round cell battery.

(a) ***Warning: To avoid possible electrolyte contamination, never use mercury thermometers to take cell temperature readings.*** Electrolyte temperature shall not exceed 110°F at any time. Electrolyte temperatures from 65°F down to freezing result in lowered battery capacity (see Table F). Elevated temperatures will result in decreased battery life (see Table C).

(b) Temperatures of cells within the same string should be within 5°F of each other. The top row of 3-tier stands is particularly apt to have higher temperatures than the bottom row. Where necessary, use fans or other means of ventilation to minimize temperature variations between cells in the same string.

TABLE F

EFFECT OF TEMPERATURE ON CAPACITY OF KS-20472 ROUND CELL

CELL TEMPERATURE		PERCENT OF RATED CAPACITY*
°C	°F	
4.44°	40°	76%
10.00°	50°	84%
15.55°	60°	90%
21.11°	70°	96%
25.00°	77°	100%
26.66°	80°	102%
32.22°	90°	107%
37.77°	100°	112%
43.33°	110°	117%

* Rated capacity is specified for cell temperature of 77°F (25°C).

(c) It is normally not necessary to measure individual cell temperatures. If it becomes necessary to measure cell temperature, insert the thermometer into the cell through the vent funnel. (See Part 3.) Completely submerge the bulb of the KS-5499, L1353, thermometer in the electrolyte for at least 2 minutes before taking a reading.

F. Specific Gravity

10.11 The specific gravity of the electrolyte used in the KS-20472 LINEAGE 2000 round cell battery is ***1.215*** instead of 1.210 normally used in lead-acid cells. Otherwise, the electrolyte is the same sulfuric acid normally used in lead-acid batteries. When measuring specific gravity, observe the following procedures.

(a) ***Warning: To avoid electrolyte contamination, hydrometers used in lead-antimony or lead-calcium cells should not be used in the KS-20472 round cells.***

(b) Measuring specific gravity as a regular maintenance routine is not required for the round cell. Specific gravity readings are recommended only when problem conditions arise. If it is necessary to measure the specific gravity of several cells, refer to Part 3 of this practice. If all cells are to be measured, see paragraph 9.01, subparagraph (a).

(c) If specific gravity readings are taken, they shall be taken before rather than after additions of water. This is because of the unmixed condition of the electrolyte after adding water. (See Practice 157-601-101.) After adding water, the round cells on float charge will regain full charge specific gravity in approximately 10 weeks.

(d) Low specific gravity readings will be obtained after a discharge [paragraph 10.08, subparagraph (b)] and will continue to read low even after the cells are fully recharged at float charge voltage (2.17 volts per cell). The reason is that recharge at 2.17 volts per cell does not generate sufficient amounts of gas to quickly mix the electrolyte and, consequently, low specific gravity readings will be temporarily obtained. In the round cell battery, low gravities will be confined only to the electrolyte above the top plate in the cell stack. If the hydrometer tube were long enough to withdraw electrolyte at various points below the top plate of the cell plate stack, the specific gravity measurements would be uniform and would indicate essentially full charge specific gravity. In approximately 10 weeks, the electrolyte above and below the top plate will have mixed sufficiently such that specific gravity readings of electrolyte above the top plate will indicate normal gravity.

(e) Observe the first group of emergency cells carefully. A series of emergency discharges may discharge the first group of emergency cells much more than the main battery or the second group of emergency cells, making cell reversal a possibility.

(f) Specific gravity readings are taken by inserting the hydrometer through the vent funnel. 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 the electrolyte. Insure that the tip of the float does not touch the stop in the bulb since this will cause erroneous readings. When taking the specific gravity reading, the open end of the hydrometer shall be covered while moving it from cell to cell to avoid splashing or throwing the electrolyte. During the process of taking a specific gravity reading, avoid dripping or spraying electrolyte from the hydrometer tube.

(g) Electrolyte specific gravity decreases as temperature increases and increases as temperature decreases. Therefore, as the temperature changes, the specific gravity readings must be corrected. Accordingly, electrolyte temperature readings must be taken when specific gravity readings are made. Thermometers have scales for correcting to the proper reference temperature of 77°F. If a thermometer with a correction scale is not available, calculate the correct specific gravity by adding 1 point (.001) to the hydrometer reading for each 3°F that the electrolyte is above 77°F or by subtracting 1 point (.001) from the hydrometer reading for each 3°F that the electrolyte is below 77°F.

G. Freezing of Electrolyte

10.12 The electrolyte in any cell must be maintained above the freezing temperature respective to its specific gravity as shown in Table G. Freezing will cause damage not immediately apparent (see Practice 157-601-101). When there is danger of electrolyte freezing, immediate steps should be taken to provide special enclosures, insulation, or heaters as necessary.

TABLE G

FREEZING TEMPERATURE OF LEAD-ACID BATTERY ELECTROLYTE

SPECIFIC GRAVITY AT 25.0°C (77°F)	FREEZING TEMPERATURE	
	°C	°F
1.030	-1.11°	+30°
1.060	-3.33°	+26°
1.090	-6.6°	+20°
1.120	-8.8°	+16°
1.150	-13.3°	+8°
1.180	-19.9°	-4°
1.210	-30.6°	-23°
1.240	-46.7°	-52°
1.270	-65.0°	-85°
1.283	-72.8°	-99°
1.300	-73.3°	-100°
1.330	-53.3°	-64°

H. Electrolyte Level and Water Purity

10.13 On KS-20472, L1, L2, L3, and L4, round cells, the electrolyte level shall be maintained between the red high- and low-level lines on the battery jar. On KS-20472, L1S, L2S, L3S, and L4S round cells, the electrolyte level shall be maintained between the black high- and low-level lines on the battery jar. Some L1, L2, L3, and L4 cells manufactured between May 1981 and August 1981 have only black level lines identical to those of L1S, L2S, L3S, and L4S cells and should have the electrolyte levels maintained accordingly. (See paragraph 6.03.) Electrolyte level checking requirements (see Table E) is dependent upon local conditions and is to be performed as required.

(a) Use only distilled water, deionized water, or other water approved for storage battery use to bring electrolyte up to the required level. Maximum allowable impurities are given in Table H. When the actual electrolyte temperature is below 50°F, do not raise the electrolyte level appreciably above the minimum level. This helps to prevent an overflow on charge.

TABLE H

MAXIMUM ALLOWABLE IMPURITIES IN BATTERY WATER

TYPE OF IMPURITY	PPM OR MG/LITER (BY WEIGHT)	PERCENT
Total Solids	500	0.0500
Fixed Solids	350	0.0350
Organic and Volatile Matter	50	0.0050
Chloride	25	0.0025
Iron	4	0.0004
Nitrates and Nitrites	15	0.0015
Ammonia	5	0.0005
Manganese	0.07	0.000007

(b) Acid or electrolyte shall not be added to any cell as a substitute for adequate charging. Do not contaminate the electrolyte of KS-20472 round cells by using electrolyte from lead-calcium or lead-antimony cells.

(c) Use the vent funnel on the cell to fill the cell to the proper level.

(d) Under no circumstances shall electrolyte be disposed of in a manner that may result in environmental pollution or damage to equipment.

The electrolyte should be neutralized where the possibility of damage may occur.

(e) ***Approval of Local Water:*** To obtain approval for local water, have it analyzed by either a local laboratory or one of the battery companies. Obtain samples as follows:

(1) Each sample should contain 1 quart of local water in a clean polyethylene or glass container with a nonmetallic closure.

Note: Current U.S. Post Office regulations concerning the shipment of liquid filled glass containers should be observed. The label on each sample should give the following data:

- Name of location
- Town and state
- Date sample was taken
- Source of water supply, such as reservoirs fed by streams, or from wells, a local well, cistern, etc.

(2) Before a particular water source can be accepted, one sample should be taken during the wet season and one during dry season. If either sample is not satisfactory, the water should not be used for batteries. It is necessary to have the water reanalyzed annually. Any formerly unsatisfactory water source can be reanalyzed whenever it is believed that excessive impurities are no longer present.

(3) Deionized water which meets the requirements in Table H is satisfactory for battery use. Deionizing systems should be equipped with a filter to remove sediment and with an organic removal resin to remove soluble organic materials from the water.

I. Discharge Capacity Test

10.14 If a cell does not take or hold a charge, a 5-hour discharge test (on fully charged cells) is the best way to determine if sufficient reserve power is available.

10.15 Practices 157-601-503, 157-601-504, 157-601-505, and 157-601-506 contain operating instructions for discharge test equipment. Discharge capacity test should be run directly off float charge without prior boost charge. The boost charge mode of the discharger-recharger shall be bypassed per Practice 157-601-504, 157-601-505, and 157-601-506 as applicable. Cells to be tested shall have been on float for at least ➧3 months➧ without a boost charge and where a power failure exceeding 30 minutes has not occurred within 6 weeks. Perform the following steps for a complete discharge capacity test.

(a) Refer to Table I and Practice 790-100-655 as applicable, for the 5-hour discharge rate of the cells to be tested. Record this value. See Fig. 16 for suggested record form.

(b) Just prior to the single cell discharge capacity test, record the following for the cell under test:

(1) Cell float charge voltage

(2) Electrolyte temperature

(3) Corrected specific gravity

(4) Presence or absence of lead-sulfate crystals.

(c) Record the time (in minutes) required to discharge the cell at the 5-hour rate to an end point of both 1.90 and 1.75 volts and the temperature at the end of discharge.

Note 1: To insure that the discharge end point of 1.75 per cell is reached, discharger—recharger equipment usually will continue the discharge until a value of 1.70 volts is reached.

Note 2: One cell at a time may be discharged without disconnecting the cell from the string, changing control equipment, or interfering with service provided that battery finish rate is not exceeded on recharge.

(d) Determine percent of 5-hour rated capacity at 77°F by adding or subtracting the correction factor K. (See Fig. 17). Use average of temperatures recorded in subparagraph (b), Step (2) and subparagraph (c). Use the following formula:

Percent of 5-hour rated capacity at 77° = [discharge time (minutes) ÷ 3] ±K (the correction factor.)

♦TABLE I♦ KS-20472 ROUND CELL 5- AND 8-HOUR DISCHARGE RATE* IN AMPERES TO 1.75 VOLTS		
KS-20472 CELLS	5-HOUR DISCHARGE RATE* IN AMPERES	8-HOUR DISCHARGE RATE* IN AMPERES
List 1 and 1S	278	200
List 2 and 2S	150	108
List 3 and 3S	86	61
List 4 and 4S	50	37
* KS-20472 L1, L2, L3, and L4 round cell rates are approximately 5 percent less than that shown in the table because of lowered electrolyte levels.		

Example 1: Assume electrolyte temperature of 60°F at start of discharge and 240 minutes to 1.75 volts. From Fig. 17, K (the correction factor), equals plus 10 at 60°F. Therefore, percent of 5-hour rated capacity is; (240/3) + 10 = 90 percent.

Example 2: Assume electrolyte temperature of 90°F at start of discharge and 318 minutes to 1.75 volts. From Fig. 17, K (the correction factor), equals minus 7 at 90°F. Therefore, percent of 5-hour rated capacity is; (318/3) - 7 = 99 percent.

(e) ***DANGER: For maximum safety, cells should not be handled during boost charge or for 24 hours thereafter. At the end of the automatic recharge cycle, the cell is being boost charged at 2.5 volts per cell and is potentially explosive.*** Recharge cells as soon as possible after discharge. The discharger-rechargers covered in Practices 157-601-504, 157-601-505, and 157-601-506 automatically recharge the cell after discharge. See Practice 169-621-301 for cell recharge after discharge with the J87116A, L1, discharger described in Practice 157-601-503.

J. Cell Reversal

10.16 Cell reversal may occur when a battery plant is allowed to discharge in excess of its rated capacity. Since stationary lead-acid cells are generally designed with excessive negative plate capacity, the positive plates in a cell can undergo reversal without the cell showing an actual reversal of cell polarity. The possibility of reversing a cell(s) should be suspected whenever a battery plant is discharged near its rated ampere-hour capacity or below an average of 1.75 volts per cell. If any cell reads 1.0 volt or less toward the end of discharge, the positive plates of that cell have probably been reversed, and the cell may present a problem on recharge.

5-HOUR RATE BATTERY DISCHARGE CAPACITY TEST RECORD FORM

OFFICE ____________ DIV. ______________ POWER PLANT CODE______________ TESTER___________ DATE_______

BATTERY DATA:

K.S. NO.	LIST NO.	MFG. NAME	TYPE BATT.	CASE MTL. RUB – PLASTIC	AGE		VOLTAGE & GROUP	NO. CELLS REG. – EMG.	TYPE OF DISCHARGER
			LEAD		YRS.	MOS.			

CELL SAMPLE
(EXCLUDE PILOT CELLS)

INDIVIDUAL CELL NO. TESTED	DATE CELL WAS TESTED	SPEC. GRAV. BEFORE START OF TEST	CELL VOLTAGE BEFORE START OF TEST	CELL TEMP. BEFORE START OF TEST	TIME TO 190V – MINS.	TIME TO 175V – MINS.	5 HOUR RATE – % (TEMP. CORR.)

GENERAL CONDITIONS NOTES ____

APPROVAL ______________________

Fig. 16—Suggested 5-Hour Rate Battery Discharge Capacity Test Record Form

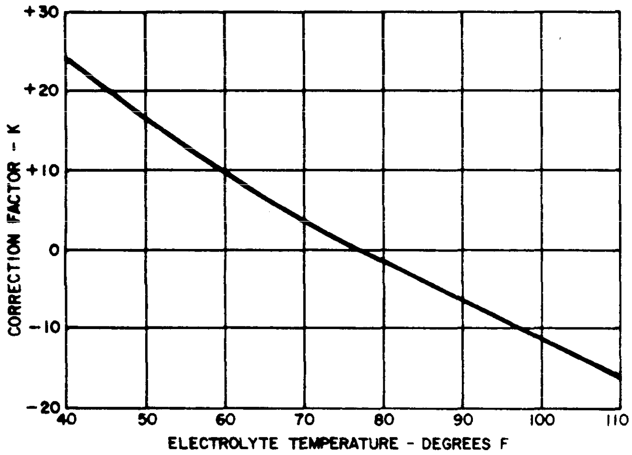

Fig. 17—Correcting Capacity to 1.75 Volts Discharge Point for Temperature (Using 5-Hour Discharge Rate)

10.17 A reversed cell typically has a high resistance; therefore, the cell voltage will be extremely high if the cell is recharged at normal rates. For severely reversed cells, it is not unusual to obtain voltages in excess of 4 volts when the cell is being recharged in series with nonreversed cells at 2.17 volts per cell average. At such high voltages, cell temperature increases rapidly and permanent damage can result. Consequently, reversed cells must be recharged slowly and with caution in order to avoid high temperatures.

10.18 ***Identification of a Reversed Cell(s):*** If a reversed cell is suspected, perform the following steps.

(1) Measure and record the battery plant voltage and plant load prior to restoring the rectifiers. Also, record the dates and times for the start of the battery discharge and when the rectifiers were restored. In addition, whenever possible, record the plant load profile during the discharge.

(2) After approximately 15 minutes of recharge, measure individual cell voltages. Any cell which measures more than 2.5 volts has been reversed and corrective action is required.

(3) If at any time the cell(s) read more than 2.5 volts, the cell(s) has been reversed and corrective action is required.

(4) Thereafter, measure the voltage and temperature of all cells every hour for a period of 5 hours.

10.19 ***Corrective Action for Reversed Cells in Battery Plant With Single String:*** Corrective action is as follows:

(1) Control the rectifier(s) output voltage so that the highest cell does not exceed 3.0 volts and/or 110°F.

(2) The voltage of the highest cell(s) should begin to decrease as this cell(s) begins to accept a charge. The time required for this to occur can vary from several minutes to weeks depending upon the degree of reversal. As the voltage of the high cell(s) gradually decreases, gradually increase the rectifier(s) output voltage (not exceeding 2.17 volts per cell) while still maintaining the high-voltage cell(s) below 3.0 volts and/or 110°F. Charging a reversed cell(s) can sometimes be accelerated by vigorously stirring the electrolyte. This is done by inserting a flexible tube down the side of the cell as close as possible to the bottom of the jar. The cell is then vigorously bubbled with filtered compressed air for 15 minutes.

(3) When all cells are reasonably uniform in voltage; i.e., all in the range of 2.07 to 2.27 volts, and recharge current is less than 5 amperes, the string shall be given an equalizing charge. The equalizing charge shall be carried out at 2.5 to 2.7 volts per cell until all diamond-like lead-sulfate crystals on the positive plate vertical columns have disappeared and shall be continued for at least 12 additional hours beyond the point of crystal disappearance. Inspection for lead-sulfate crystals is done with a flashlight as described in paragraph 5.07. The equalizing charge will require bringing in an auxiliary string of cells and spare charging equipment so that the string to be charged can be disassociated from the working plant. If this is not possible, the equalizing charge can be performed on an individual cell basis using a single cell charger.

10.20 ***Corrective Action for Reversed Cells in Battery Plant With Parallel Strings:*** Corrective action is as follows:

(1) If all strings have reversed cells, follow the procedures outlined in paragraph 10.19.

(2) If all strings do not have reversed cells, disconnect the string(s) with reversed cells from the power plant, allow the string to stand on open circuit for 24 hours, and follow the procedures outlined in paragraph 10.19.

10.21 If the reversed cells fail to respond to the corrective procedures given, contact the regional AT&T Bell Laboratories field representative for further assistance.

10.22 ***Contingencies for Reversed Cell(s):*** If the reversed cell(s) fails to respond to the procedures in paragraphs 10.19 and 10.20, the procedures in paragraphs 10.23 and 10.24 may be attempted.

10.23 ***Shunting Around Reversed Cell(s):*** Shunt around the high-voltage cell(s) which will allow maximum recharge current to flow through the nonreversed cells. This may be done by paralleling the high-voltage cell with a suitably sized resistor or with a single cell discharge unit in order to maintain the high-voltage cell(s) between 2.0 and 3.0 volts. Once the nonreversed cells have been recharged, the shunt can be removed from the reversed cell(s) and the reversed cell(s) can then be charged with a single cell charger at 2.5 to 2.7 volts at the highest available current. The above shunting procedures becomes impractical if more than two cells have reversed in a string.

10.24 ***Disconnecting Reversed Cell(s) From Battery String:*** Disconnect the reversed cell(s) from the string and charge these individually or in parallel at 2.5 to 2.7 volts. Meanwhile, charge the nonreversed cells in series at 2.5 to 2.7 volts per cell.

(a) After the reversed cell(s) are disconnected from the battery string or shunted around, an equalizing charge must be applied as described in paragraph 10.19, Step (3).

(b) Contact the regional AT&T Bell Laboratories field representative if further assistance is required.

K. Boost Charge

10.25 A boost charge should be given, where possible, to the main battery and for the emergency cells if they have had any appreciable discharge, in order to accelerate return to a full charge condition. In plants where boost charge facilities or capabilities are not available, eventually full charge will return to a discharged battery on normal float charge in 2 to 3 days. (See Practice 157-601-101.) Boost charges after power failure are given where possible to the entire string for durations depending upon charging voltage as shown in Table J. Special boost charges, including those made necessary by the presence of lead-sulfate crystals on one or more cells, may be given to the string or to certain selected cells only. (See Practice 169-621-301.) ***Bring battery to full charge or nearly so before start of boost charge.*** Cells are close to full charge when the current through them at charge voltage is too low to be read on plant ammeters or when the differences between charger output and load as read on the plant ammeters has been constant for 10 minutes. See Practice 157-601-701 and Table J for additional information on boost charging and finish rates.

L. Battery Connections

10.26 ***Battery Connection Corrosion: 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 intercell connector near the grounded end of the battery, to discharge the static electricity from your body.*** Battery connections shall be tight and free from corrosion. Corrosion from electrolyte leakage will not normally occur except by careless handling of the hydrometer syringe when measuring specific gravity. 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.

> ***Note:*** For high-voltage applications, see Practice 157-629-703.

10.27 ***Opening Battery Connection: DANGER: An explosion could occur when sparks are created near the battery string.*** Observe the following before loosening or removing battery connection while cells are gassing or discharging as sparks may occur.

TABLE J

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

(1) ◆***Caution: Overtighting of the intercell connectors could strip the bolt and/or nut threads resulting in loose connections.***◆ Ensure that all intercell connections are tight with the exception of the connection that is being opened for cleaning or other purposes.

> *Note:* Two 6-point box wrenches should always be used to tighten a connection, in order to insure a good connection and to avoid the possible breakage of the lead posts or damage to lead-covered nuts.

(2) ◆***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.*** When opening or replacing connections on cells, it is strongly recommended that a procedure be employed similar to that illustrated in Fig. 18 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. Even if commercial power has not failed, a disconnected battery no longer acts as a filter across the rectifier output, and the excessive transients resulting in the rectifier may cause a loss of service in the plants. The switch is to be closed before opening or replacing the battery connector. The size of the switch strap and temporary wiring must be sufficient to carry the load under power failure conditions.

10.28 ***Cleaning Battery Connections:*** Prior to cleaning battery connections, observe the admonishments in subparagraphs (a) through (d).

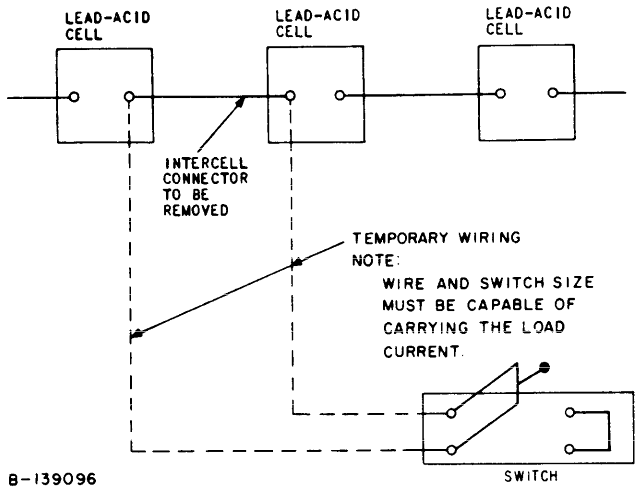

Fig. 18—Typical Temporary Switch Connected to Remove Arc Hazard

(a) ***DANGER: Bore brush rod and handle must be of a nonconductive nature. A short across both terminals or to ground can be fatal.***

(b) ***Warning: Do not allow neutralizing solutions to enter the cell.***

(c) ***Warning: 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.***

(d) ***Warning: Do not use sandpaper, stiff wire brushes, or other abrasive tools on intercell connectors or fastening hardware as this will remove the protective lead coating.***

(e) Clean the corroded post, intercell connectors, and terminal details using a cloth dampened in a ***strong soda solution,*** followed by wiping with a cloth dampened in clear water.

(f) Use a round, soft-bristled, bore brush to clean terminal post bolt holes for intercell connectors.

(g) Sandpaper the sides of each terminal post to which connections are made to a bright finish. Avoid abrading the intercell connectors of the fastening hardware.

(h) Coat the hardware with heated NO-OX-ID A (regular or special) compound.

(i) Clean the ***contact*** areas of intercell connectors and terminal by wiping or brushing with a soft brush and then coated with heated NO-OX-ID A (regular or special) compound.

Note: The NO-OX-ID A regular compound can be heated by placing the can of compound in hot water of 160°F or more. Heat compound until it can be easily applied with a brush. NO-OX-ID A special compound does not require heating and can easily be applied to connections with a brush.

10.29 ***Removing Jumper:*** If a temporary jumper was used, as shown in Fig. 18, reconnect the intercell connector and remove the wiring. If a temporary jumper was not used, close the opened connections. Tighten all connections securely and wipe off excess compound.

Note: After removing one end of the jumper, insulate the loose end before loosening the other end.

M. Cell Jars and Covers

10.30 ***Warning: Use only water to clean the PVC cell container and cover.*** Dripped electrolyte on cells should be neutralized with a weak soda solution followed by wiping with a cloth dampened in clear water. Inspect jars and covers annually and clean if required.

N. Spacing Between Cells

10.31 Cell spacing was determined at initial installation. It should, however, be rechecked in event of earthquakes or other severe shocks.

O. Antiexplosion Features

10.32 The safety vent funnel tube on all KS-20472 cells has been lengthened to accommodate the lowered electrolyte level. All KS-20472, L1, L2, L3, and L4, round cells with the lowered electrolyte level (new red level lines) should have an extension attached to the original tube. All KS-20472, L1S, L2S, L3S, and L4S round cells should be equipped with either the extension tube or the new longer safety vent funnel tube. Any vent tube which does not extend below the red level lines or new black lines must be modified by AT&T Technology Installation. If there are any questions concerning the extension tube, contact the AT&T Technology QSM (Quality Service Management).

10.33 ***Warning: Do not allow gas vents to become clogged as electrolyte overflow due to internal pressure may result.*** If the antiexplosion feature (vent funnel) becomes clogged, pressure will build up inside the cell. The vent funnel is the screw type and may be removed by turning counterclockwise one-fourth turn. Neutralize vent funnels in a ***weak soda solution*** and clean with water and a brush if they become clogged. If vent funnels are damaged, they should be replaced.

> *Note:* Modified safety vents (extensions added) which become defective must be replaced with modified safety vents.

P. Battery Stands, Cabinets, and Miscellaneous Equipment Maintenance

10.34 ***Warning: Do not use solvents to clean PVC cell container (jar).*** To remove spilled epoxy from the jar, allow it to dry, then scrape it off.

10.35 ***Warning: At no time shall the wire brush be brought in close proximity to cell terminals and intercell connectors.*** Battery stands, cabinets, etc., should be wiped at regular intervals with a cloth dampened in a ***weak soda solution*** [see subparagraph (a) of paragraph 3.04] and then with a cloth dampened in clean water. Corrosion on metal battery stands should be cleaned with a metal brush. The corroded area should be wiped clean with a cloth dampened with a weak soda solution, followed by cloth dampened in clean water. The wire brush may also be used to remove old paint prior to repainting.