

KS-20472 "BELLCELL*" BATTERY
DESCRIPTION, INSTALLATION, AND MAINTENANCE
HIGH-VOLTAGE UNINTERRUPTABLE POWER SUPPLY (UPS) APPLICATION

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1. GENERAL

1.01 This section includes description, installation, and maintenance instructions for the KS-20472 BELLCELL lead-acid storage battery used in UPS Systems. Special emphasis is placed on precautions and procedures suitable for high-voltage/high-current UPS Systems under 600 volts.

1.02 The Equipment Test List (ETL) is affected.

1.03 Conventional lead-acid theory and definitions generally apply to the KS-20472 BELLCELL battery. Refer to Section 157-601-101. Additional information on the BELLCELL battery can be found in Sections 157-629-701 and 157-629-702.

1.04 The BELLCELL battery, designed by Bell Telephone 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 Bell System UPS usage.

2. DESCRIPTION

A. Unique Features of the New Cell

2.01 A major feature of the BELLCELL battery 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 (Fig. 1) for maximum strength. A new 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 The jar and cover are made of a transparent, flame-retardant, rigid, polyvinyl chloride (PVC) material with improved impact and craze resistance which exceeds New Equipment Building Systems (NEBS) general equipment requirements. Refer to Section 800-610-164. The jar and cover are sealed using a new heat-sealing technique. (See Fig. 2.)

2.03 A post-cover seal (Fig. 3) 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. 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. Tests have indicated that these post seals will remain free of leakage in excess of 40 years. This combination of leak-free seals and a flame-retardant, high impact container provides a cell design uniquely suited for both safety and maintenance to the high-voltage/high-current UPS applications.

2.04 Utilizing the new features of the cylindrical cell and based upon extensive laboratory and field tests, it is anticipated the BELLCELL battery will have 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 sulphuric acid (H_2SO_4) normally used in lead-acid batteries. For a description of chemical action during charge and discharge, see Theory of Operation in Section 157-601-101.

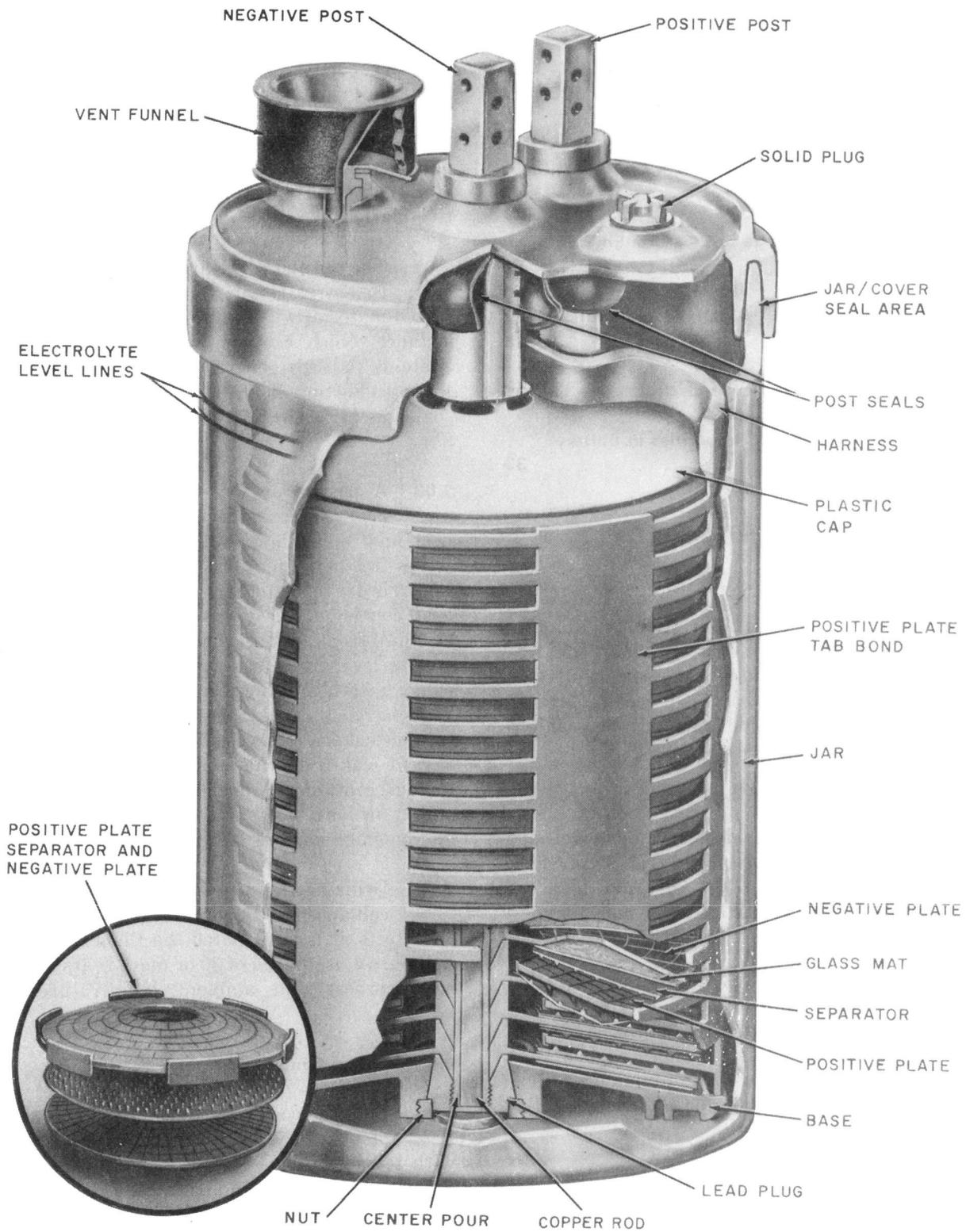


Fig. 1—KS-20472 BELLCELL Battery Cutaway View

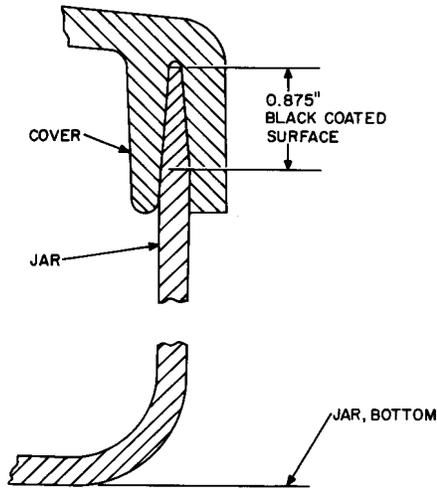


Fig. 2—Jar-to-Cover Seal

C. Physical Construction

2.06 The cylindrical shape provides a mechanically strong structure for the pure lead circular plates. The positive plates are bonded by melting the connecting tabs together (Fig. 1) at the outer perimeter of the plates. The negative plates are joined by pouring a molten lead-antimony alloy down the center hollow core formed by the mating negative plate hubs. Jar-to-cover sealing is accomplished (Fig. 2) 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. The primary seal is constructed of an epoxy sleeve cast onto the post. The secondary seal is a rubber sleeve (Fig. 3) which allows at least 1/2 inch of vertical movement within the jar without transmitting any stress to the cover or post seals.

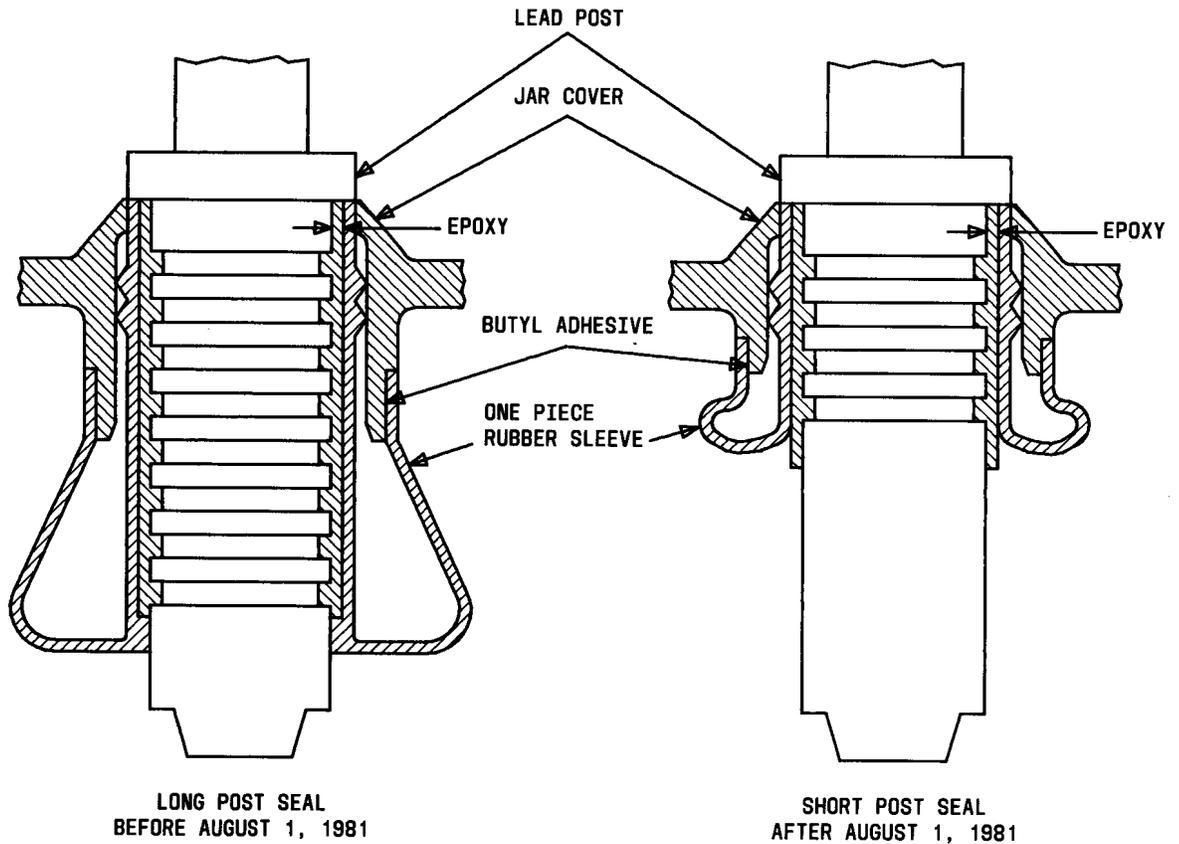


Fig. 3—BELLCELL Battery Post Seals

SECTION 157-629-703

2.07 KS-20472, L-1S, L-2S, L-3S, and L-4S

BELLCELL batteries are essentially identical to the older KS-20472, L1, L2, L3, and L4 cells, except that they contain a new post seal design which removes the epoxy-lead interface from the acid and thereby significantly increases the lifetime of the post seal. Cells with the new post seal design have black electrolyte level lines similar to the original BELLCELL battery design. On the KS-20472, L1, L2, L3, and L4 cells, new red electrolyte level lines have been added to indicate the lower 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. All KS-20472 cells are 14-1/2 inches in diameter and differ only in the plate stack heights. The list numbers with their cell capacity and heights are listed in Table A.

D. Anticipated Cell Life and Comparison to Conventional Cell Life

2.08 The BELLCELL battery has been designed for continuous float service in excess of 30 years in ambient temperatures of 90°F. Elevated temperatures reduce the life of all lead-acid cells. The BELLCELL battery float life is compared to conventional cell float life in Table B.

E. Advantages of the BELLCELL Battery Over Conventional Cells for UPS Applications

2.09 Increased safety features for high-voltage UPS applications are as follows:

- (a) Post and cover seals which stop acid creepage to the outside of the jar thereby eliminating:
 - Personnel exposure to high-voltage hazard from 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.

(b) Nonconducting, nonflammable battery stand which eliminates accidental grounding, fire hazards, and danger to attendant personnel.

(c) Post and intercell connectors are recessed from the aisle and are shielded by PVC covers and by the stand which effectively forms a 5-sided enclosed cabinet.

(d) Noncrazing or noncracking, flame-resistant jar and stand material which exceeds Bell System NEBS flammability requirements.

(e) Low maintenance which minimizes exposure of maintenance personnel to high-voltage hazards by eliminating routine measurements of individual cell voltage, specific gravity, and temperature, and minimizing the need to add water.

2.10 Additional advantages over the conventional cells are as follows:

- (a) Increased life.
- (b) Cell capacity increases with age.
- (c) Ease of handling and reduced installation effort.

TABLE A

RATED CELL CAPACITY AND HEIGHT FOR "BELLCELL" BATTERY

KS-20472 LIST NO.	CAPACITY (AMP HR) AT 5-HOUR RATE TO 1.75 VPC (77°F)	AMPS 15-MINUTES TO 1.65 VPC	AMPS 30-MINUTES TO 1.65 VPC	CELL HEIGHT (INCH) TO TOP OF TERMINAL
1 and 1S	1450	1440	1200	26 9/16
2 and 2S	725	840	600	18 11/16
3 and 3S	400	500	360	15 3/16
4 and 4S	240	330	240	13 7/16

- (d) Battery size is standardized.
- (e) Plate growth problem eliminated.
- (f) Compact cell configuration in a 3-tier modular stand arrangement.
- (g) Battery and stand are designed as a system which provides reduced maintenance in earthquake and hardened sites.

TABLE B

FLOAT LIFE EXPECTANCY "BELLCELL" BATTERY VS CONVENTIONAL BATTERY

BELLCELL BATTERY LIFE (YEARS)	AMBIENT TEMPERATURE	KS-15544 CELLS AND KS-5553 500 SERIES LIFE (YEARS)
70	77°F	15
35	90°F	7
20	100°F	4

3. SAFETY PRECAUTIONS AND ELECTROLYTE NEUTRALIZATION

A. Bodily Protection

Danger: Due to high voltages and currents associated with a UPS battery, unless explicitly stated otherwise, the following precautions shall be followed whenever work must be performed on the battery.

3.01 Multiple Ground Protection: To prevent multiple grounding of the UPS battery strings, the following precautions shall be followed:

Caution: When the battery string(s) is disconnected from the UPS, the ability of the system to withstand a commercial power disturbance may be severely limited or eliminated. Appropriate measures should therefore be taken to avoid a possible system outage.

- (1) The UPS battery string(s) shall be isolated from all equipment by opening the required circuit breaker(s) or appropriate disconnect switch. At this time, the battery will be completely ungrounded to minimize risk to personnel.

- (2) ***Only one person shall work on a UPS battery string at any given time.*** However, it is required that an additional person be present to observe all procedures.

- (3) Intentional grounding of any point in the battery string is prohibited.

Note: The intent of the following precautions is to prevent multiple grounds from being placed on the battery at the same time. The resultant voltages and currents that would occur are extremely hazardous and can be lethal.

Danger 1: Use of insulated wrenches is mandatory.

Danger 2: Use of a flashlight having plastic or rubber housing is mandatory.

Danger 3: Insulating floor mats must be installed in the aisle of the battery rack.

Danger 4: During UPS discharges, intercell connectors may reach temperatures of 140°F or higher. Do not touch intercell connectors or connector guards during discharge or immediately thereafter.

3.02 Electrical Shock and Burns Protection:

Body protection is provided by wearing rubber gloves, rubber apron, and using ***insulated tools*** and ***insulated flashlights***. When it is necessary to work on a rack of batteries that cannot be reached from the floor, the use of a nonconductive ladder is required. ***Reaching over one cell to work on another is never permitted. When working on a battery, metal jewelry (and large belt buckles) should be removed.*** Care should be taken to assure that only authorized personnel have access to the battery plant and that they have been fully briefed on the hazards of high-voltage work and precautions necessary for handling lead-acid batteries.

Danger: Wear protective equipment such as rubber gloves, rubber aprons, and splash-proof goggles when performing any activity involving handling of electrolyte, cells containing electrolyte, or maintenance activities requiring exposure to electrical shock or electrolyte contact from these cells.

3.03 Electrolyte Burn Protection: Bodily protection from electrolyte burns is provided by wearing splash-proof safety goggles, rubber gloves, and a rubber apron when working with lead-acid batteries.

Note: Freedom from jar cracks and electrolyte leakage greatly reduces fire hazard and electrolyte neutralization problems, but the same precautions must generally be observed that are common with conventional cells.

B. First Aid

3.04 First Aid for Electrolyte in Eyes or on Skin: In case of electrolyte splashes, use of the KS-21527 eyewash kit is recommended. However, if the KS-21527 kit is not available, use the following procedure. Immediately remove electrolyte splashed on the skin or in the eyes by flushing the affected area with large amounts of plain tap water. In case of electrolyte in the eye, pour water into the inner corner of the eye and allow at least 1 quart of water to run over the eye and under the eyelid. A drinking fountain near at hand may be utilized for this purpose. Eye injuries should be placed under the treatment of a physician, preferably an eye specialist, as soon as possible.

Note: The KS-21527 eyewash kits are now required in all battery installations. The eyewash kits may be placed on building columns, along walls, or at the end of battery stands so that a bottle will be within about **12 feet** at any point in the battery area.

C. Explosion and Fire Prevention

3.05 Explosion Hazards: Under normal float, discharge, and recharge conditions, no explosion hazard exists with properly vented BELLCELL batteries. Nevertheless, it is prudent to take precautions against static sparks at all times, and **especially during boost charge (2.4 volts or greater) and for approximately 24 hours thereafter when an explosive concentration of hydrogen exists within the cell. If a spark (as from a static discharge) enters the cell under these conditions, an explosion may occur. For maximum safety, it is recommended that the cells not be handled during this period.** The black plug and vent funnels on cells made prior to February 1, 1982, may be equipped with black, carbon-containing rubber gaskets. These black

gaskets have been shown to provide a conducting path for the spark to enter the cell. When such cells are to be boost charged, and handling of the cell may be required, it is required that the black gaskets be replaced with the new brown nonconducting rubber gaskets. Prior to installing the new gasket, any residue from the existing black gasket must be completely removed from the cell cover and sealing surface of the black plug and vent funnel by vigorously rubbing the cover surface with a cloth **lightly dampened** with methyl-alcohol, taking care that no alcohol enters the cell. **Alcohol which enters the cell may affect grid corrosion or float behaviour and adversely impact cell performance or life.** Cells which have the nonconducting gaskets installed under both the black plug and vent funnel may be handled normally during and after boost charge. However, all normal precautions for avoiding static or other sparks, open flames, etc, should be followed. For further information on gas explosion hazards, see Section 157-601-101.

3.06 While leakage of electrolyte is not expected to occur, spillage or leakage might form a low resistance path to ground. Avoid spillage which, in addition to being hazardous, can cause corrosion of metal parts.

3.07 Electrolyte overflow from the vent funnel indicates clogged vents, which constitutes an explosion hazard, and requires that the vent funnel be replaced (see paragraph 9.26).

D. Electrolyte Corrosion

3.08 Corrosion Due to Electrolyte: Most metals and vegetable and animal products are corroded by electrolyte unless it is promptly neutralized.

E. Neutralizing Agents

Caution: Both electrolyte leakage and neutralizing solution used for cleanup of electrolyte spills may result in conducting paths with attendant high-voltage hazard. See paragraphs 3.01 through 3.03 and 9.01 for precautions to be observed in cleanup.

3.09 Agents for Neutralizing Lead-Acid Battery Electrolyte: The following agents are approved for neutralizing electrolyte spills.

- (a) **Soda solutions** are used for general neutralization of electrolyte. A **strong soda**

solution, used primarily to neutralize spilling or dripping of electrolyte, is made by combining either 2 pounds of table soda (bicarbonate) or 1 pound of washing soda with 1 gallon of water. One gallon of strong soda solution should neutralize approximately 3/4 pint of electrolyte. A **weak soda solution** for neutralizing traces of electrolyte should be 1/8 the strength of the strong solution. After using a soda solution, always wipe the neutralized surface with a cloth dampened in clean water.

Note: In the event of large spills of electrolyte, agricultural or industrial lime may be used for neutralization.

(b) **A household ammonia solution** consisting of one part ammonia to two parts water should be used for neutralizing electrolyte on clothing since this solution will not cause fabric spotting as readily as a soda solution. Use caution when opening ammonia bottles because pressure tends to build within them, and ammonia liquid in vapor form is harmful to the eyes and nose. Also, do not use ammonia near rotating charging equipment.

4. INSTALLATION PROCEDURES

A. Manufacturers Identification and Serial Numbers

4.01 Each 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 9-digit serial number is composed of a 4-digit date of manufacture code (year-month), followed by a 5-digit (WE) cell identification number. All records and correspondence addressing specific cells should include the manufacturer and the 9-digit serial number.

Note 1: All cells manufactured by C&D between January 1972 and October 1975 have the 9-digit serial number stamped on the top of the negative post instead of 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 for these cells is stamped on the top of the negative post as part of the 9-digit serial number (first four digits).

(a) **Factory Location Code:** The cell label contains the manufacturer's name and a single

letter code identifying the manufacturing location. R designates C&D batteries, Leola, Pennsylvania and S designates Gould IBD, Fort Smith, Arkansas.

(b) **Serial Numbering:** Examples of serial numbering are as follows:

(1) The serial number consists of nine digits. The first four digits indicate the year and month of manufacture. The remaining five digits is the individual cell identification number.

R 730130021

R = C&D — Leola, Pennsylvania

7301 = 1973 January

30021 = Cell (WE) identification number.

(2) Blocks of the 5-digit cell (WE) identification number have been assigned to each manufacturer as indicated:

C&D

January 1972 through December 1979:

20,000 through 40,999

January 1980 on:

50,000 through 99,999

GOULD

November 1975 through December 1979:

1 through 19,999

January 1980 on:

1 through 49,999.

B. Marking on Depolarized Cells

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

(a) Marking at manufacturer prior to shipping:

(1) The C&D cells have either a P or a hexagon outside a circle, or an asterisk (*) stamped on top of the negative post.

(2) The Gould cells have either an N or an asterisk (*) stamped on top of the negative post.

(b) Marking in the field:

- (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 Cells manufactured prior to May 1981 should have two sets of level lines (one set red, one set black) on the cell jar. On these cells, the electrolyte level must be maintained between the lower (red) set of level lines. Cells manufactured after August 1981 should have only one set of black level lines, which are higher than the red lines and slightly lower than the black lines mentioned above. On these cells, designated L-1S, L-2S, L-3S, and L-4S, the electrolyte level 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 Installation

4.04 The cell shall not be tipped more than 25 degrees in order to prevent electrolyte spillage through the vent. To minimize spillage, cells shipped on pallets should be left on their pallets until their final location is reached.

E. Electrolyte Spillage and Plate Exposure

4.05 Before unpacking a cell, examine the shipping container, and record signs of electrolyte spillage or external damage.

4.06 Check electrolyte level of cells immediately after unpacking. If possible, spillage should be noted before unpacking. Record any action taken in the initial charge report.

Note 1: Vent funnels shall be stored in a convenient protected location until final torquing of intercell connectors is completed. (See paragraph 4.27.)

Note 2: At the time of manufacture, the electrolyte level of cylindrical cells is adjusted between the level lines when the cells are floated 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.

Note 3: 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.

4.07 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.

4.08 If the electrolyte level is below the point at which the plastic cap is attached to the negative post (Fig. 1), the battery is not acceptable for installation because excessive spillage is indicated. If the electrolyte is 1/2-inch below the low-level marking on the battery jar but above the cap, fill with 1.215 ± 0.005 specific gravity electrolyte to the low mark on the battery jar.

4.09 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 9.14) before shipment, as necessary to bring electrolyte level to minimum, and note action taken in report to manufacturer.

4.10 The specific gravity of installed and charged cells shall be 1.215 ± 0.005 . See specific gravity readings and temperature corrections in paragraph 9.12.

4.11 Any visible damage shall be noted in the records prior to seeking replacement.

4.12 After checking electrolyte level, measure and record specific gravity before the cell is hoisted into place (see paragraph 4.28).

F. Cleaning Cell Container and Terminals

Warning: Use only water to clean the jars.

4.13 If the jar is dirty when removed from the shipping crate, the jar should be cleaned with water and wiped with a cloth dampened in clean water before installing in the rack.

4.14 Cells are shipped with the posts coated with NO-OX-ID A compound (R-3266). If there is evidence that the posts have come in contact with acid due to electrolyte spillage, the posts should be cleaned by removing the NO-OX-ID A compound, neutralizing the posts with a weak soda solution, and wiping the neutralized surfaces with a cloth dampened in clean water (see paragraph 3.09). The posts and all other exposed lead surfaces, including the round shoulder below the square post, should then be recoated with NO-OX-ID A compound.

G. Hoisting Cells Into Place

4.15 The cover is designed with a lip for lifting purposes. Special hoists, similar to the action of ice tongs, have been designed specifically for lifting the cell from its shipping crate onto the battery stand. The R-4701 hoist has been designed specifically for installing cylindrical 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 R-4701 hoist. The lifting clamp, which utilizes an action similar to that of an ice tong, 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 electrically operate hoist is available for installing cells in pre-assembled stands and on single row arrangements mounted against a wall. The R-4800 hoist is equipped with the R-4702B lifting clamps. An R-4900 shelf jack is available for lifting individual cells out of the battery stand well. An R-4902 battery dolly is available to transport the cells and was designed specifically to complement the BELLCELL battery hoists and stands.

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

Note: The National Electrical Code has been interpreted to require a minimum spacing of 4 feet between stands.

4.16 The use of KS-20760 polyester battery stands is mandatory. 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 multitiered stands, the telephone company should provide shields for the radiators, blinds for the windows, or special ventilation for the multitiered stands to provide less than 5°F temperature variation from the top to the bottom tier in a string.

Danger: *The room temperature vulcanized (RTV) silicone rubber is mildly toxic until cured and should be applied in a well ventilated working area.*

Warning: *For hardened-site installations and in earthquake Zone 4, L1 and L-1S cells are limited to stands two tiers high.*

Caution: *In the UPS application, the top tier shall be equipped with back panels and top base assembly.*

4.17 The two parts from which the stand is assembled are shown in Fig. 4. 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. 5 and provides mounting space for two cells. The backs are available in three different heights to accommodate the four cell sizes. The module is assembled by inserting the back panels, as shown in Fig. 4, 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. 6 and 7.) 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. 7.)

I. Orienting and Spacing Cells in Stands

4.18 The space between cells is governed by the locating wells in the bases of the polyester battery stands. Cell position shall be checked after each earthquake or severe shock.

4.19 The BELLCELL battery is shipped with two types of plugs. The black plug is a solid plug

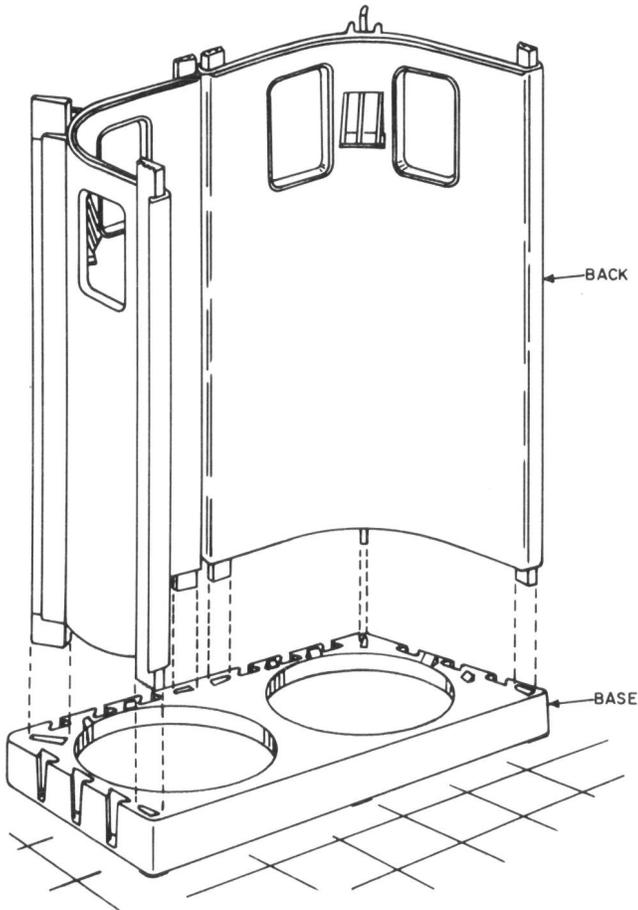


Fig. 4—Polyester Battery Stand (Typical) Before Assembly

and the orange shipping plug is vented. After unpacking, orient the cell on the stand for proper polarity (see Fig. 9). 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 1: After final torquing of interconnections in accordance with paragraphs 4.25 and 4.26, the orange plug will be replaced by the vent funnel.

Note 2: In some arrangements (Fig. 9), the cell orientation will not allow removal of the black plug after the intercell connectors are installed. This is not a problem since removal of this plug is not required or recommended during normal maintenance.

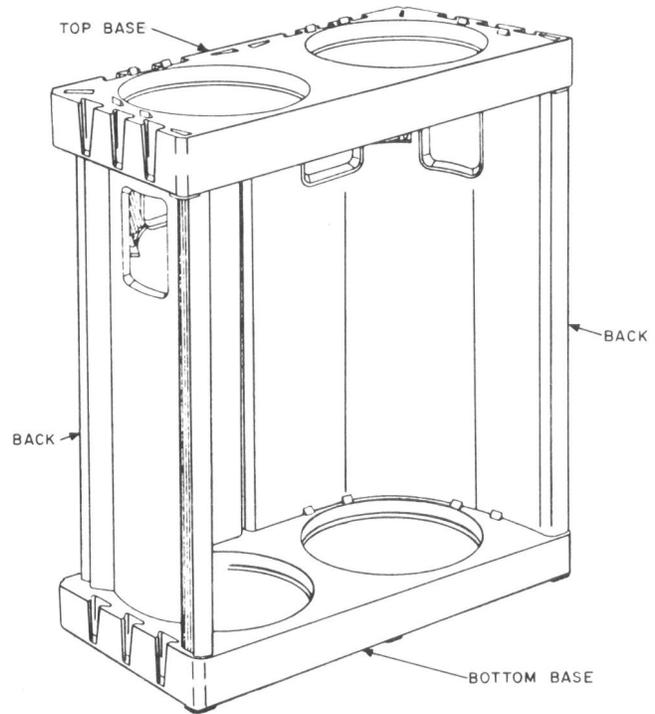


Fig. 5—Basic Module for Two BELLCELL Batteries



Fig. 6—Polyester Base and Back Assembly

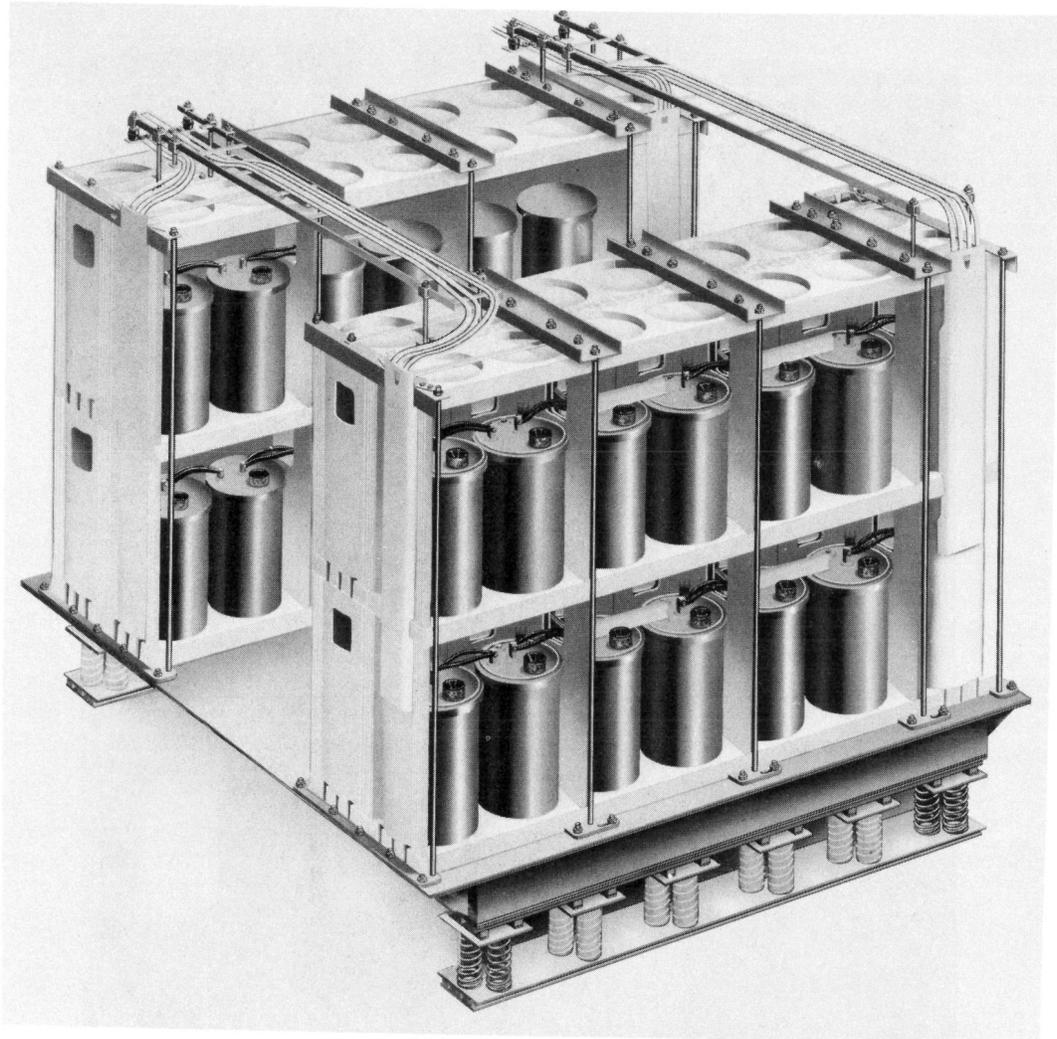


Fig. 7—Typical Polyester Glass Battery Stand for KS-20472, L1, and L-1S BELLCELL Batteries Mounted on Shock Isolation Platform in 50 PSI Hardened Environments

J. Intercell Connectors (KS-22385)

Note: For UPS usage, special intercell connectors, nuts, bolts, and PVC guards are required. See ED-82868-30.

4.20 At no time shall battery intercell connectors be filed, scraped, sandpapered, or brushed with a wire brush as this will remove the protective lead coating. Apply NO-OX-ID A compound, using a typewriter brush or similar stiff brush to coat all contact surfaces between the post and intercell con-

nectors, if removed for cleaning. Apply compound to threads of connector bolts and to threads of nuts. See paragraph 9.22 for method of heating and applying NO-OX-ID A compound.

K. Cell Interconnection-Precautions

4.21 Because of the large number of cells installed in a UPS battery string and the resulting high-voltage, extra precautionary measures must be followed by the installer while interconnecting the

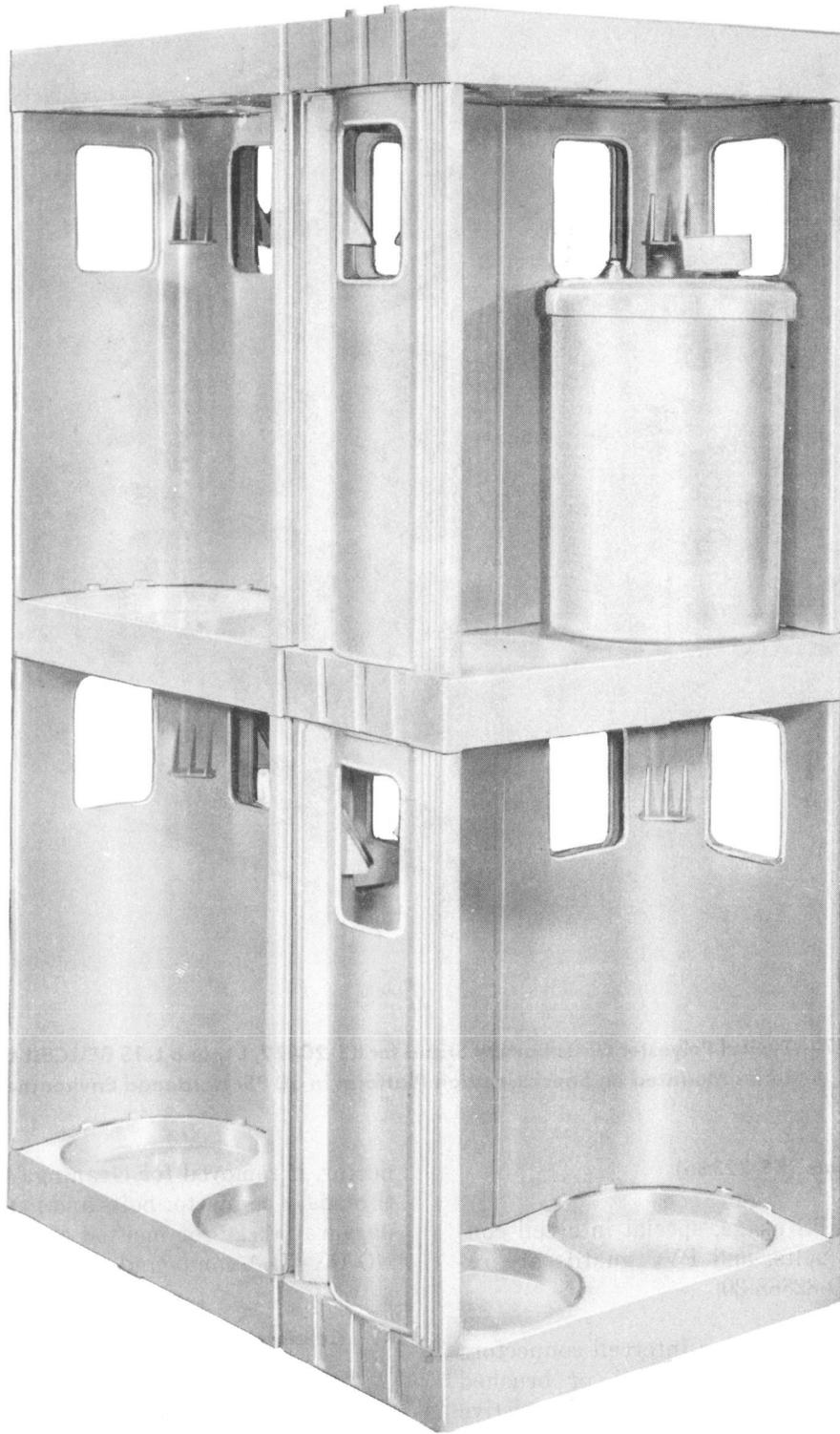
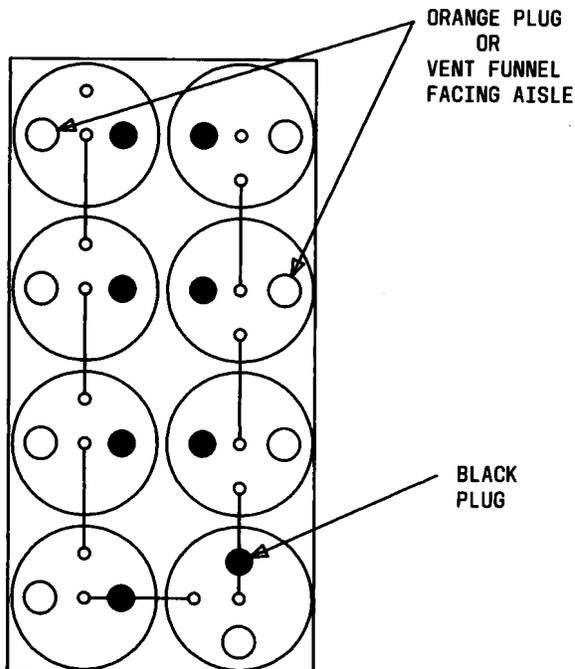


Fig. 8—KS-20472 BELLCELL Battery Mounted on Polyester Stand



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

Fig. 9—KS-20472 BELLCELL Battery Orientation

cells to ensure maximum protection from high-voltage shock.

Danger: Final interconnection and all subsequent operations shall be performed by one person only. See Subpart 3(A).

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

4.22 Do not interconnect cells by following a progression from the first to the last cell. Instead, interconnect cells in groups of no more than 50 (see paragraphs 5.03 and 6.04). **Be absolutely sure that the cell groups have not become grounded in any way.** If the cells are to be charged in their final string configuration, in the battery stands, the final interconnections shall be made between each of the cell groupings. After completing all final battery interconnections, the battery string

shall be connected to the charging equipment **through an open switch or circuit breaker.**

4.23 The use of R-3154 protective sheeting is required when making interconnections between cell groups. The installer must stand on a piece of R-3154 sheeting while making the connections. This will serve as an insulator and protects the installer from shock which could result from accidental grounding.

4.24 Cell interconnection is a safe installation activity as long as the installer remains alert and follows the above procedures and precautions.

L. Tightening of Intercell Connectors

Caution: When connecting, disconnecting, or working near battery cell posts, taped or insulated tools are necessary to prevent accidental short circuits.

4.25 It is a requirement of the UPS battery plant that the intercell hardware be tightened with a torque indicating wrench to a torque of 150 inch-pounds. Use a correctly fitted 6-point or 12-point box wrench for backing purposes, and a beam-type torque indicating wrench for the tightening operation.

M. Verification of Connector Integrity

4.26 Before battery initial charge begins, check and examine all connections for tightness. Retighten where necessary. A period of 3 or 4 days is desirable between the initial tightening and rechecking operation, if time permits. Otherwise, the length of the interval is optional. After verifying all battery connections for tightness, recoat any exposed surfaces of the battery post. Remove excess NO-OX-ID A compound, but retain a thin film.

N. Vent Funnel Installation and Disposition of Vent Plugs

Danger 1: Vent funnels with cracks, breaks, or other defects in the bayonet or funnel stem below the gasket constitute an explosion hazard during initial or boost charging above 2.35 volts. Defective funnels must be replaced before charging the cell.

Danger 2: Insure that the tip of the funnel is completely submerged below

the electrolyte level to eliminate explosion hazard.

4.27 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.

O. Hydrometers

4.28 Check and assemble the KS-5499, L1306, hydrometer as follows:

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.

(a) **Assembling the Hydrometer Syringe:**

The hydrometer syringe should be assembled 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 (1), (2), and (3), fit the rubber parts to the glass barrel.

Warning: Hydrometers used in lead-antimony or lead-calcium cells should not be used in KS-20472 BELLCELL batteries since this would contaminate the electrolyte.

(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.

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.

(c) **Specific Gravity Reading:** 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, the electrolyte level in the hydrometer should be brought to eye level.

P. Temperature Reference Cell Selection

4.29 During the installation period, a cell shall be selected and designated as the **temperature reference cell** within **each tier**. The temperature reference cell is selected for 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 KS-20472 BELLCELL batteries are shipped charged and wet. The maximum time that a charged and wet cell may stand on open circuit shall not exceed 6 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.

Danger: Safety precautions given in paragraphs 4.21 and 4.22 must be followed.

Warning: If the storage temperature exceeds 90°F, the open circuit time should not exceed 4 months.

- (a) Maintain the battery on continuous float 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) Give a boost charge at 2.5 to 2.6 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 BELLCELL batteries prior to turnover to the customer. The purpose of an initial charge is to compensate for self-discharge that has taken place in the interval between cell manufacture and installation. The initial charge voltage shall be in the range of 2.5 and 2.55 volts per cell. Temperature shall be determined by designating a temperature reference cell as described in paragraph 4.29. Cell temperatures higher than 110°F are not permissible during initial charge.

C. Procedure for Initial Charge

Danger 1: High-voltage precaution and procedures given in paragraph 3.01 must be followed.

Danger 2: Wherever practical, cells should not be handled during boost

charge or for 24 hours thereafter. Where handling is required, observe all cautions and procedures in paragraphs 3.05 and 4.19, Note 1.

5.03 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. Generally 5 amps per string is all that is required to charge a string of cells at 2.5 volts per cell. The charge voltage shall be between 2.5 and 2.55 volts per cell average. After reaching the regulated voltage, charging is continued for the number of hours indicated in Table C corresponding to the temperature of the coldest temperature reference cell in each string. The average cell voltage is determined by dividing the total battery voltage by the number of cells in the string. This voltage should be measured at the charging equipment and recorded at least once a day during the initial charge. Routine measurement of individual cell voltages is not required.

5.04 Continuous charging without interruption is preferred in order to save time. 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 C, 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 cylindrical cells is preadjusted by the manufacturer to be

TABLE C

TOTAL HOURS OF CHARGE AT 2.5 THROUGH 2.55 VOLTS PER CELL (NOTE 1)

TIME ON OPEN CIRCUIT (NOTE 2)	CELL TEMPERATURE (NOTE 3)		
	81°F AND ABOVE	65 TO 80°F	64°F AND LESS
Less than 4 months	100 Hours	150 Hours	200 Hours
Greater than 4 months	150 Hours	200 Hours	250 Hours

Note 1: Total charging time should not exceed 250 hours.

Note 2: 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.

Note 3: Cell temperature shall be determined by selecting a "temperature reference cell" as described in paragraph 4.29.

between the level lines when the cells are floated at 2.17 volts for an extended period of time (see paragraph 6.03).

D. Requirements at End of Initial Charge/Identification of Crystals

5.05 After a satisfactory initial charge, there should be no lead-sulphate 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 crystals or gray coloration. The disappearance of 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 crystals or gray coloration occurs from top to bottom during initial charge. To insure total absence of crystals or grey coloration, inspection for crystals should be concentrated at the bottom of the positive plate vertical columns. Crystals can readily be 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-sulphate crystals will appear as sparkling diamond-like reflecting particles as shown in Fig. 10, or as a gray coloration.

5.06 Cells which are not free of 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. If charging fails to clear the crystals within 250 hours, the cells should be reported to Western Electric, Purchased Product Inspection (PPI), via a Route G Job Information Memorandum (JIM) for investigation and/or replacement.

5.07 Before stopping the initial charge, record the following:

- (a) Total hours of charge
- (b) Temperature of at least one cell in each tier of each battery string
- (c) Presence or absence of crystals for each cell.

E. Equalizing Voltage of Strings Paralleled Into Existing Plant

5.08 When adding a new string in parallel to an existing string, the initial charge should be given to the new string only. (See paragraph 5.03.)

Danger: Connections at the battery shall not be made or opened while cells are gassing or for 24 hours thereafter. (See the explosion prevention precaution in paragraph 3.05.)

5.09 When connecting a string in parallel to another string, the final connection should be made through an open switch or circuit breaker. Before closing the switch or circuit breaker, both strings should be approximately the same potential (less than 0.05 volts difference) to prevent arcing. String voltage should be equalized by either lowering the voltage of the higher string or raising the voltage of the lower-voltage string.

F. Charging Cells Added to a String

5.10 New cells may be intermixed directly into an existing string of cells when necessary for replacement purposes if the original cells have been treated with platinum depolarizer. (All new cells are factory treated with platinum depolarizer.)

5.11 If the original cells have not been factory or field depolarized, platinum depolarizer solution should be added. (See paragraph 4.02.)

5.12 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.

Danger: Wherever practical, cells should not be handled during boost charge or for 24 hours thereafter. Where handling is required, observe all cautions and procedures of paragraphs 3.05 and 4.19, Note 1.

Caution: Do not exceed 250 hours total charge at 2.5 to 2.55 volts per cell.

5.13 Should it become necessary to replace one or more cells in a battery string, the replacement

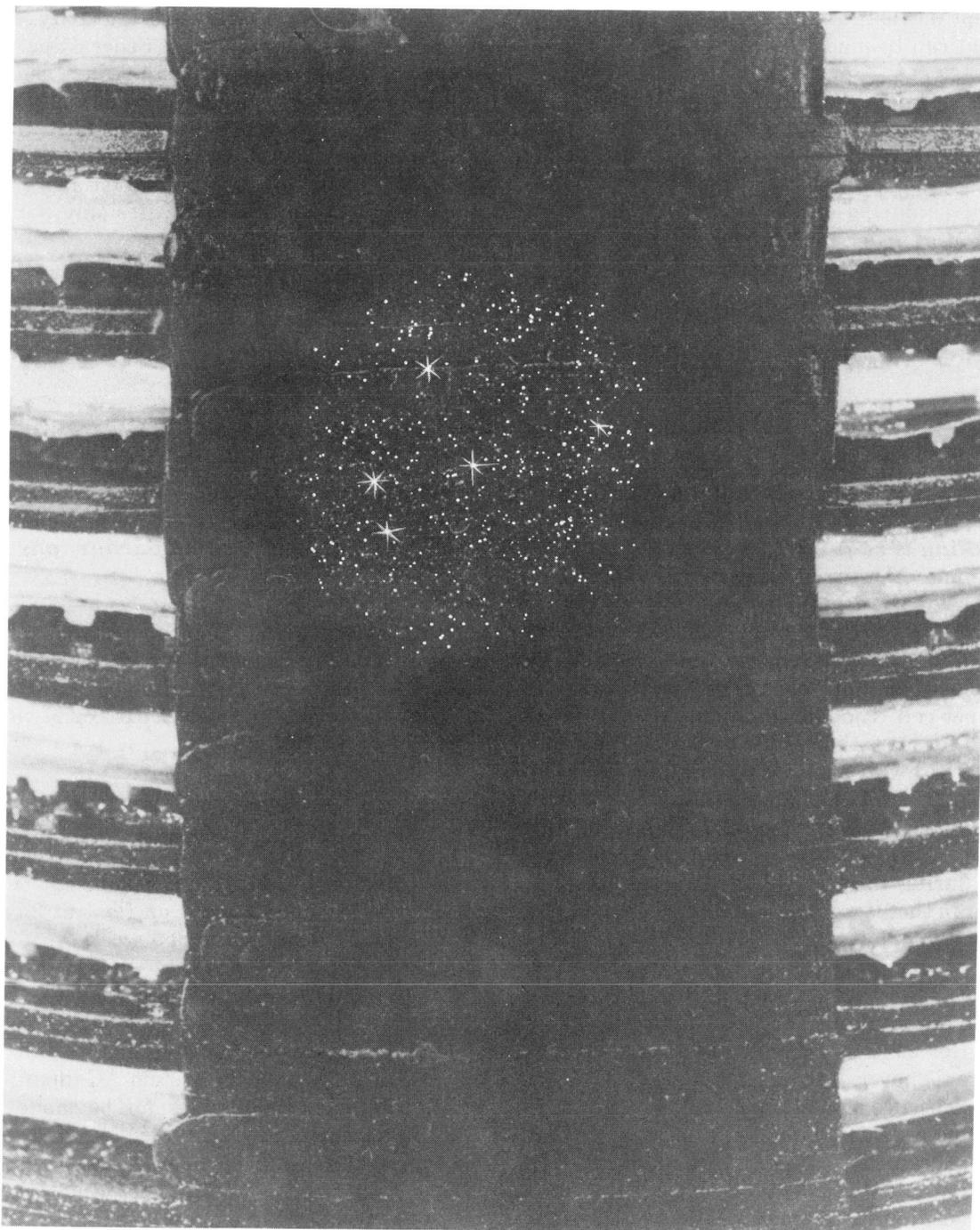


Fig. 10—Lead Sulphate Crystals on Positive Plate Column

cells must be initial charged on a separate rectifier until crystals have disappeared. The cells(s) should then be kept on float at 2.17 volts per cell until the replacement can be made.

Note: Unless the maximum plant load is less than 400 amps and battery voltage is less than 140 volts (in which case 4/0 gauge cables could be used), no attempt at paralleling cells should be made during the replacement operation. Therefore, under most circumstances the battery string will have to be isolated during the replacement operation.

6. FROM INITIAL CHARGE TO TURNOVER

A. Float Procedures and Requirements

Danger: *Wherever practical, cells should not be handled during boost charge or for 24 hours thereafter. Where handling is required, observe all cautions and procedures of paragraphs 3.05 and 4.19, Note 1.*

6.01 At the end of initial charge, the battery should be placed on continuous uninterrupted float 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 97-1285, Fig. 11 and 12. A battery that is left on open circuit for more than 24 hours after initial charge may develop crystals. These crystals are expected to disappear during the 2.17-volt float period prior to turnover or in the 10-week acceptance period thereafter. (See paragraph 9.07.)

6.02 From initial charge to turnover, batteries 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 crystals. Measure cell voltage on crystalline cells. If any cell(s) is heavily crystalline (see paragraph 5.05, phase 1) **and** reads 2.09 volts or less, it is shorted and should be reported to Western Electric PPI via a Route G JIM for replacement. If any cell(s) is crystalline and reads greater than 2.09 volts, it is expected that the crystal will clear prior to turnover or during the 10 week period after turnover. (See paragraph 9.07.)

6.03 Electrolyte levels should not be adjusted until the cells have been on continuous float 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.

B. Final Connection of Cell Groups

Danger 1: *High-voltage precautions and procedures given in paragraph 3.01 must be followed.*

Danger 2: *Wherever practical, cells should not be handled during boost charge or for 24 hours thereafter. Where handling is required, observe all cautions and procedures of paragraphs 3.05 and 4.19, Note 1.*

6.04 In those cases where cells were divided into smaller groupings for initial charge, disconnect cell groupings and reconnect into final configuration. Place on continuous float at 2.17 volts per cell within 24 hours.

Note: The tests and records in Parts 6 and 7, performed by the UPS vendor and overseen by Western Electric, are a normal part of every UPS installation, and should not be run until the battery has been on float at 2.17 volts per cell for a minimum of 1 week.

C. Discharge Acceptance Test

6.05 With the UPS delivering its full rated kW load, remove the system AC input power. The following measurements shall be made using the UPS panel meter(s) for current levels and a digital voltmeter for voltage levels.

- Battery current
- Battery voltage
- UPS output voltage and current (each phase).

These values shall be recorded every 5 minutes until approximately 5 minutes remain in the expected dis-

charge period. (A UPS alarm is generally given at this time.) Data shall then be recorded every minute until the "Low Battery" shutdown occurs. The total discharge time shall be compared to the requested discharge interval (normally 15 minutes). In the event that the desired discharge interval is not achieved, further testing and evaluation per paragraph 6.07 must be performed.

D. Recharge

6.06 When the UPS system is restored to service, all load shall be removed and the battery shall be recharged. Using the UPS panel meter(s) for current and a digital voltmeter for voltage, record battery current and battery voltage. Measurements shall be taken approximately every 10 minutes until the total battery current approaches zero amps.

E. Insufficient Battery Reserve

6.07 In the event that the battery fails to provide sufficient reserve capacity, the following steps should be taken:

- (1) Verify the original battery calculations utilizing the data taken in paragraph 6.05 and Power Data Section 5.75, Sheet 18.
- (2) Check all power connections between the inverter and the battery, including intercell connectors, and tighten where required.

Note: Evidence of NO-OX-ID A compound melting and flowing off the terminal and onto the cell cover is indicative of terminal overheating (high resistance connection).

- (3) After the battery has been on float for a minimum of 24 hours, repeat paragraph 6.05.

6.08 In the event that the preceding procedure does not result in the calculated battery discharge interval, the cells shall be reported to Western Electric PPI via a Route G JIM for investigation and/or replacement.

7. RECORDS UNTIL TURNOVER

Note: Form ID-1285 has been replaced by Form SD-97-1285 (Fig. 11 and 12) which is recommended for use to record initial charge data.

7.01 It is suggested that records be kept on Western Electric Form SD-97-1285.

7.02 Record serial numbers of all cells and their positions in the battery string (see paragraph 4.01).

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 turnover.

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 During the initial charge, record the battery string voltage and the reference cell temperature once a day.

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

7.07 From initial charge to turnover, record battery string float voltage weekly.

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

7.09 Temperature readings should be to the nearest degree; for example, 77°F.

7.10 *Two copies of the initial charge report shall be turned over to the telephone company.* One of these copies should be filed by the telephone company at the office as a permanent record to be maintained during the life of the battery.

8. APPARATUS

8.01 *List of Tools, Materials, and Test Apparatus:* The following tools, materials, and test apparatus are used in this section:

TOOLS	DESCRIPTION
-	Bore Brush
-	Flashlight, regular or angular, having plastic or rubber housing

SECTION 157-629-703

TOOLS	DESCRIPTION	TOOLS	DESCRIPTION
-	3-inch and 6-inch Wrench Extension		type) Federal Specification 0-S-801B
-	6-Point or 12-Point Box-end Wrench as required for bolt-connectors. Insulate wrenches with plastic or rubber tape or tubing. The entire unused end of double-end wrenches must be thoroughly insulated.	-	Glass or Plastic Funnel† (obtained locally)
R-2969	Typewriter Brush	-	Household Ammonia
R-3154	Protective Sheeting	-	Neoprene Gloves, Charleston Rubber Co, N140-R (size 9) or N141-R (size 10), for lighter work
R-3448*	Hoist (Square Cell)	-	Overshoes, rubber (obtain locally)
R-4052	Torque Indicating Wrench, Beam-Type, 150 inch-pounds application	-	Table Soda (bicarbonate)
R-4701*	Gantry	-	Water, distilled or approved for use in storage cells (see paragraph 9.14)
R-4702A*	Clamp, Battery Lifting	-	Wiper Paper, Scott No. 58 or 59
R-4786	Gantry Extension (Required for 3-tier arrangements)	-	Sandpaper
R-4800*	Hoist	R-3034	Gloves, Acid Resistant (for heavy duty)
R-4900*	Shelf Jack	R-3043	Apron, Acid Proof
R-4902*	Battery Dolly	R-3266	NO-OX-ID A Compound (for batteries)
KS-21527, L3	Eyewash Kit	R-4365	Hat, Safety Hard
KS-21527, L4	Eyewash Solution	R-4501	Goggles, Chemical Safety
MATERIALS		R-4517	Coverall, Chemical, Disposable
-	Agriculture or Industrial Lime (may be purchased locally)	KS-14666	Cloth
-	Alcohol, Methyl USP grade	TEST APPARATUS	
-	Container (glass, glazed porcelain, plastic rubber, earthenware or lead—for handling electrolyte or water)	KS-5499, L1306	Hydrometer (for low-gravity cells)
-	Electrolyte*, 1.215 ± 0.005 Specific Gravity at 60°F (manufacturer's	KS-5499, L1353	Thermometer
		KS-20599, L4	Digital Multimeter

*Required only for installation

† Required only for installation

9. REQUIREMENTS AND MAINTENANCE AFTER INSTALLATION

A. Rules for Good Battery Maintenance

9.01 The following rules should be adhered to:

- (1) Maintenance operations which require direct physical contact with cells, connectors, etc, should not be performed without first isolating the string if the plant float voltage is greater than 160 volts.
- (2) Maintain correct float voltage values (2.17 ± 0.01 volts per cell).
- (3) Maintain electrolyte level between the high- and low-level markings on the jar by the addition of approved water. (See paragraph 9.14.)
- (4) Avoid excessively high electrolyte temperatures.
- (5) Keep battery clean.
- (6) Avoid using an open flame near batteries.
- (7) Avoid creating sparks, including those from static electricity, near batteries.

B. Battery Records and Readings

9.02 Maintain complete battery records for each string within an office. 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 cell temperatures whenever battery maintenance routines are carried out. It is not necessary to take the temperature of each individual cell. The temperature of one cell on each tier is sufficient. It should not be necessary to touch the thermometer in each tier.
- (c) Although existing forms are not consistent with the new maintenance routines for cylindrical cells (see paragraph 9.03), it is recommended that Forms E-3593 or E-2003 (Fig. 13)

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 crystals. The letter N (for no) should be used to record the absence of crystals, and the letter Y (for yes) should be used to record the presence of crystals.

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

C. Battery Maintenance on Float

9.03 Maintenance routines for the cylindrical cell have been significantly modified and simplified in comparison to rectangular cells. Field experience has shown that the presence or absence of crystals is a much more accurate indicator of battery condition than voltage and specific gravity readings and allows for easy inspection of cells.

9.04 For detailed requirements and maintenance intervals, see Table D. For details of float operation, see Section 157-601-301. This section is applicable for general requirements only and maintenance intervals shall be in accordance with Table D.

D. Battery Float Voltage

9.05 *It is extremely important to maintain a battery float voltage of 2.17 ± 0.01 volts per cell average.* The KS-20599, L4, 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.

E. Lead-Sulphate Crystals

9.06 Cells shall be inspected for lead-sulphate crystals as described in paragraph 5.05. Under normal float conditions, cells should be free of crystals.

9.07 If crystals appear within a 10-week period of normal float operation after turnover of the

TABLE D

KS-20472 "BELLCELL" BATTERY MAINTENANCE INTERVALS

MAXIMUM INTERVALS	DESCRIPTION OF OPERATION	REQUIREMENTS	REFERENCE INFORMATION
1 Week	Battery Float Voltage Reading	2.17 ±.01 Volts/Cell Average	Paragraph 9.05
3 Months	Inspect Individual Cells for Crystal	No Crystals	Paragraph 9.06
3 Months	Temperature of One cell per Tier	Not more than 5°F Variations	Paragraph 9.11
12 Months	Electrolyte Level	Between High and Low Level Marks	Paragraph 9.14
12 Months	Terminals and Connectors	No Corrosion 150 inch-pounds	Paragraph 9.20
12 Months	Inspect jars, covers, and stands. Clean if necessary	—	Paragraphs 9.24 and 9.27

battery plant, the Operating Company shall be entitled to cell replacement and reinstallation on a non-billable basis. Such an unsatisfactory float condition should be reported using the established Engineering Complaint procedures.

9.08 Throughout the life of a battery plant, the absence of crystals indicates that the cells are floating properly and maintaining a full state of charge.

9.09 If 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 crystals may indicate a low battery float voltage. Check to see if the battery string float voltage is 2.17 ± 0.01 volts per cell. Make appropriate rectifier adjustments if necessary. (See paragraph 9.05.)

(b) **Plant Discharge:** A battery discharge as a result of a power failure or other reasons may

produce crystals on the cells. This is normal with all lead-acid cells since lead-sulphate is the material produced when a lead-acid cell is discharged. If the cause of the 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 crystals will occur from top to bottom in the cell stack. Therefore, inspection for lead-sulphate 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.***

9.10 If 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 9.09.)

Danger: High-Voltage precautions and procedures given in paragraph 3.01 must be followed.

- (b) Measure the cell voltage. If the crystalline cell(s) reads 2.09 volts or less and the cell is heavily crystalline (see paragraph 5.05, 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 crystals. If temperature differences in excess of 5°F are found, appropriate ventilation should be provided to correct the condition.
- (d) If the problem is not attributable to a shorted cell (b) or temperature variations (c), the cell(s) should be reported as an Engineering Complaint. Copies of the battery records should accompany the complaint.

F. Temperature

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

- (a) Electrolyte temperature shall not exceed 110°F at any time. Electrolyte temperatures from 65°F down to freezing result in lowered battery capacity. Elevated temperatures will result in decreased battery life (see Table B).
- (b) Temperatures of cells within the same string should be within 5 degrees of each other [see subparagraph 9.10(c)]. 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.

Warning: Never use mercury thermometers to take cell temperature readings.

- (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.

G. Specific Gravity

9.12 The specific gravity of the electrolyte used in the BELLCELL battery is 1.215 instead of the usual 1.210 normally used in lead-acid cells. Otherwise, the electrolyte is the same sulphuric acid (H₂SO₄) normally used in lead-acid batteries. When measuring specific gravity, observe the following procedures:

- (a) Measuring specific gravity as a regular maintenance routine is not required for the cylindrical 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 section. If all cells are to be measured, see subparagraph 9.01(1).
- (b) 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 Section 157-601-101). After adding water, the BELLCELL batteries on float will regain full charge specific gravity in approximately 10 weeks.
- (c) Low specific gravity readings will be obtained after a discharge [subparagraph 9.09(b)] and will continue to read low even after the cells have been fully recharged at float 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 BELLCELL 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 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.
- (d) 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. In- sure 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 hydrom- eter tube. [Observe all safety procedures in Part 3 and subparagraph 9.01(1).]

Warning: Hydrometers used in lead-antimony or lead-calcium cells should not be used in the KS-20472 BELLCELL bat- teries since this would contaminate the electrolyte.

(e) Electrolyte specific gravity decreases as tem- perature increases and increases as tempera- ture decreases. Therefore, as the temperature changes, the specific gravity readings must be cor- rected. 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.

H. Freezing of Electrolyte

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

I. Electrolyte Level and Water Purity

9.14 On KS-20472, L1, L2, L3, and L4 BELLCELL batteries, the electrolyte level shall be main- tained between the red high- and low-level lines on

TABLE E

FREEZING TEMPERATURES OF ELECTROLYTE

SPECIFIC GRAVITY AT 77°F	FREEZING TEMPERATURE (°F)
1.030	+ 30
1.060	+ 26
1.090	+ 20
1.120	+ 16
1.150	+ 8
1.180	- 4
1.210	- 23
1.240	- 52
1.270	- 85
1.283	- 99
1.300	-100
1.330	- 64

the battery jar. On KS-20472, L1-S, L2-S, L3-S, and L4-S, the electrolyte level shall be maintained be- tween the black high- and low-level lines on the bat- tery jar. Some L1, L2, L3, and L4 cells manufactured between May 1981 and August 1981 have only black level lines identical to those of L1-S, L2-S, L3-S, and L4-S cells and should have the electrolyte levels maintained accordingly (see paragraph 6.03). Elec- trolyte level checking interval (see Table D) is depen- dent upon local conditions and is to be performed as required in the ETL Section 157-001-011.

(a) Use only distilled water, deionized water, or other water approved for storage battery use to bring electrolyte up to the required level. Maxi- mum allowable impurities are given in Table F. 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.

Warning 1: Acid or electrolyte shall not be added to any cell as a substitute for adequate charging. Do not contami- nate the electrolyte of KS-20472 cells by using electrolyte from lead-calcium or lead-antimony cells.

Warning 2: Plastic funnels will not con- taminates, but must be rinsed with clean water before using to fill different type cells. Only clean plastic funnels shall be used.

TABLE F
MAXIMUM ALLOWABLE IMPURITIES IN
BATTERY WATER

TYPE OF IMPURITY	PPM (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

Warning 3: *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. See Part 3.*

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

(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 telephone company
 - 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 F 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.

J. Cell Reversal

9.15 In the event of a commercial power outage where standby AC power is not utilized or available, lower priority UPS loads may be shed. Under these conditions, the load on the battery plant may be significantly reduced and a long, low rate discharge may occur which could result in cell reversal.

Caution: *Discharges under reduced load which result in cell reversal constitute an extreme abuse of the battery which may render it incapable of providing required reserve for an extended period (up to several weeks) and which is not correctable in service. Therefore, under no circumstances should the battery plant be subjected to any discharge conditions for periods in excess of 2 hours. In the event reversal occurs, emergency provision should be made to protect priority loads against subsequent AC outages which may occur before the reversed battery string has recovered its full reserve. This may take several weeks.*

9.16 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 irreparable damage can result. Consequently, reversed cells must be recharged slowly and with caution in order to avoid high temperatures.

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

(1) Measure and record the battery 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.

Danger 1: Do not touch any cell which has evidence of moisture on the exterior of the jar (see Part 3).

Danger 2: Use only one hand to touch the cell.

Danger 3: Insure that the craftperson is standing on rubber floor mats.

(2) After approximately 1 hour of recharge, gauge cell temperature by placing hand on cell jar wall. Cells significantly hotter than the remainder may indicate a reversal. Hot cells should be noted and their individual cell voltages and temperatures measured.

(3) Thereafter, measure the suspected cell voltage and temperature hourly for a period of 5 hours.

(4) If at any time the cell(s) read more than 2.5 volts or 110°F, then the cell(s) has been reversed and corrective action is required.

9.18 Corrective Action: Corrective action for reversed cells in single and parallel battery strings are as follows:

(a) **Battery Plant With a Single String Which Cannot Be Disassociated From the Power Plant:** Corrective action is as follows:

(1) Control the rectifier(s) output voltage such 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.

(3) When all cells are reasonably uniform in voltage; ie, all in the range of 2.07 to 2.27 volts, and recharge current is less than 5 amps, 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-sulphate 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 crystals is done with a flashlight as described in paragraph 5.05. 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.

(b) **Battery Plant With Parallel Strings:** Corrective action is as follows:

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

(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 (a).

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

K. Battery Connections, Use of NO-OX-ID A Compound

Danger: Do not attempt to loosen, remove, or reconnect battery connections while cells are in service. See Part 3 and Subparagraph 9.01(1).

9.20 Battery connections shall be tight and free from corrosion. Check connections annually for corrosion and retorque to 150 inch-pounds, (see paragraph 4.25). 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 in accordance with paragraphs 9.21

through 9.23. If a connector appears damaged or corroded, a scheduled removal of the battery from the UPS must be planned. However, if the battery voltage is under 160 volts and the maximum design load per string is under 400 amps, the jumper procedure depicted in Fig. 14 may be used.

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

9.21 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.

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

Warning 1: *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.*

Warning 2: *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.*

9.22 Terminal post bolt holes for intercell connector mounting hardware may be cleaned by using a round, soft-bristled, bore brush. The sides of

each terminal post to which connections are made should be sandpapered to a bright finish without abrading the intercell connectors of the fastening hardware and coated with heated NO-OX-ID A compound. The **contact** areas of intercell connectors and terminal should be cleaned by wiping or brushing with a soft brush and then coated with heated NO-OX-ID A compound.

Note: The NO-OX-ID A 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.

9.23 If a temporary jumper was used, as shown in Fig. 14, 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 1: After removing one end of the jumper, insulate the loose end before loosening the other end.

Note 2: A torque wrench and box wrench must always be used to tighten a connector to the required torque of 150 inch-pounds (see paragraph 4.25).

L. Jars, Covers, and Spacing Between Cells

Warning: *Use only water to clean the PVC cell container and cover.*

9.24 Dripped electrolyte on cells should be neutralized with a weak soda solution followed by

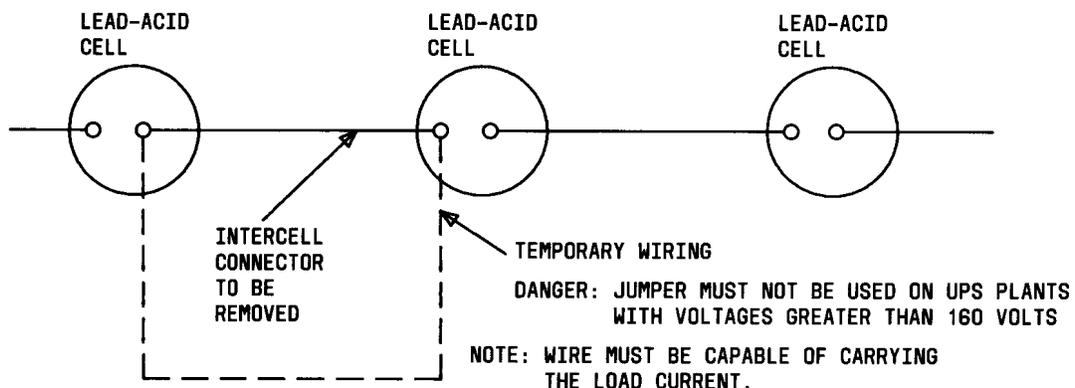


Fig. 14—Typical Temporary Jumper Connection for Cleaning Intercell Connections

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wiping with a cloth dampened in clear water. Inspect jars and covers annually and clean if required.

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

M. Antiexplosion Features

Warning: *Do not allow gas vents to become clogged as electrolyte overflow due to internal pressure may result.*

9.26 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, (see paragraph 4.27).

N. Battery Stands, Cabinets, and Miscellaneous Equipment Maintenance

9.27 Battery stands, cabinets, etc, (Table D) should be wiped at regular intervals with a cloth dampened in a weak soda solution and then with a cloth dampened in clean water.