



Round Cell Batteries
KS-20472

Product Manual
Select Code 157-629-700
Comcode 107852477
Issue 8
January 2008

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Notice:

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1 Introduction

Round Cell Batteries

Product Summary This product manual provides information on Lineage Power Round Cell Batteries.

A Round Cell battery is a stationary, lead-acid, flooded cell. All of the components in the Round Cell battery meet strict specifications and quality standards. Nearly one million Round Cells are in service today—an unparalleled record of experience and trustworthiness.

Designed to provide long reliable service life and reduced lifetime maintenance costs, the Round Cell is appropriate for both high discharge rate uninterruptible power supply (UPS) applications and low discharge rate (standby reserve) applications. Applications include telephone central offices, microwave stations, rapid rail systems, power utility sub-stations, and generating plants.

Round Cell Batteries, continued

Illustration

Figure 1-1 shows a cut-away view of the Round Cell Battery.

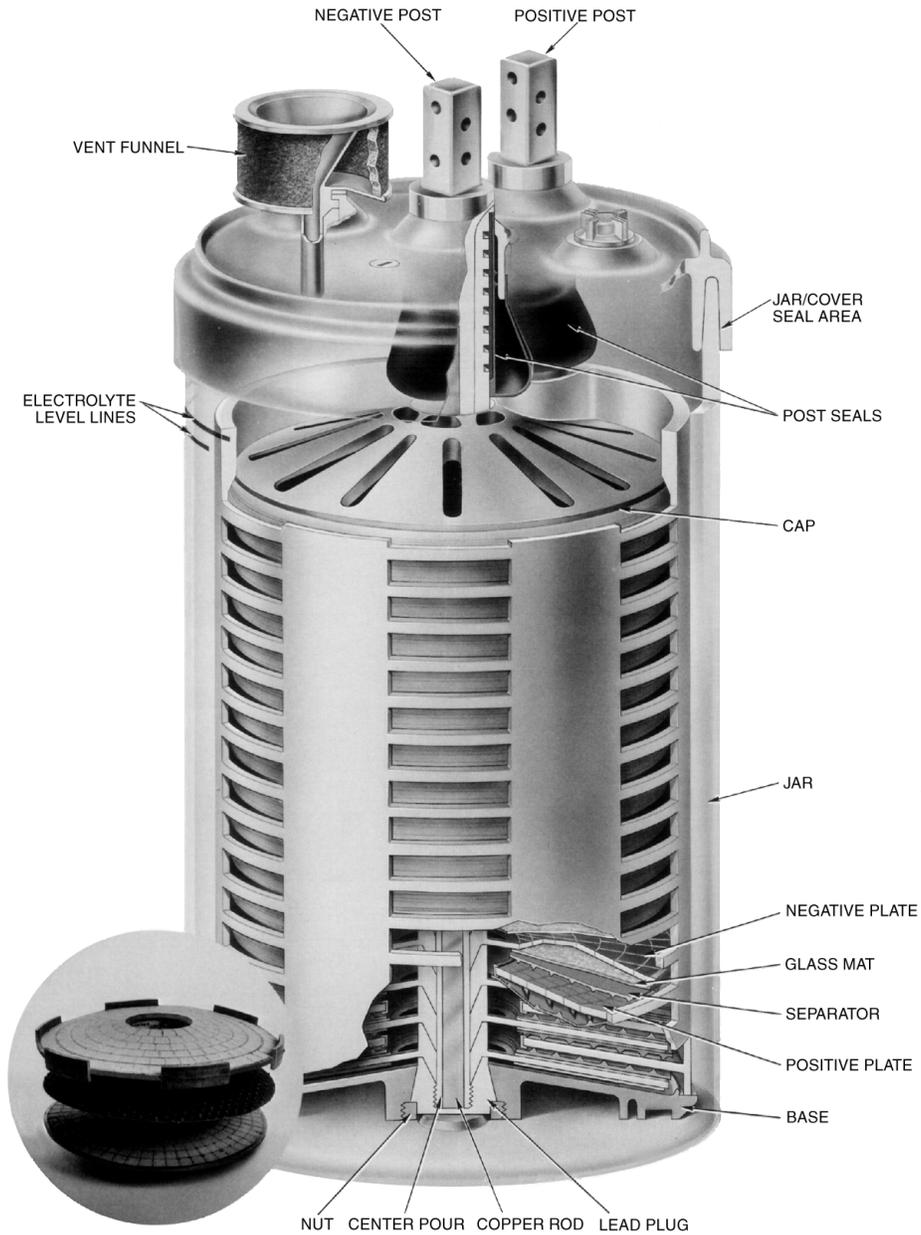


Figure 1-1: KS-20472 Round Cell (cutaway view)

Customer Service Contacts

Customer Service, Technical Support, Product Repair and Return, and Warranty Service

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-THE-1PWR (1-800-843-1797). This number is staffed from 7:00 am to 5:00 pm Central Time (zone 6), Monday through Friday, on normal business days. At other times this number is still available, but for emergencies only. Services provided through this contact include initiating the spare parts procurement process, ordering documents, product warranty administration, and providing other product and service information.

For other customers worldwide the 800 number may be accessed after first dialing the AT&T Direct country code for the country where the call is originating, or you may contact your local field support center or your sales representative to discuss your specific needs.

Customer Training

Lineage Power offers customer training on many Power Systems products. For information call 1-972-284-2163. This number is answered from 8:00 a.m. until 4:30 p.m., Central Time Zone (Zone 6), Monday through Friday.

Downloads and Software

To download the latest product information, product software and software upgrades, visit our web site at <http://www.lineagepower.com>

2 *Product Description*

Overview

Specifications

The Round Cell Battery is available in four models. All four models have a common post size that allows for common intercell connectors.

The specifications for these models are provided in Table 2-A.

**Table 2-A: Round Cell Battery Specifications
(Specific Gravity 1.215 Acid Models)**

	KS-20472 List 1S	KS-20472 List 2S	KS-20472 List 3S	KS-20472 List 4S
Ampere Hours (8 hour rate @ 25°C/77°F)	1600 Ah	864 Ah	488 Ah	296 Ah
Weight	346 lbs 156.9 kg	198 lbs 89.8 kg	133 lbs 60.3 kg	100 lbs 45.4 kg
Height	26-3/4" (67.94 cm)	18-7/8" (47.94 cm)	15-3/8" (39.05 cm)	13-5/8" (34.60 cm)
Diameter	13-3/4" (34.92 cm)	13-3/4" (34.92 cm)	13-3/4" (34.92 cm)	13-3/4" (34.92 cm)
Total Weight (Volume) of Electrolyte	85 lbs (8.4 gal) 38.6kg (31.7 L)	50 lbs (4.9 gal) 22.7kg (18.7 L)	34 lbs (3.4 gal) 15.4kg (12.7 L)	26 lbs (2.6 gal) 11.8kg (9.7 L)
Total Weight (Volume) of Sulfuric Acid	24.7 lbs (1.6 gal) 11.2 kg (6.1 L)	14.5 lbs (0.95 gal) 6.6 kg (3.6 L)	9.9 lbs (0.65 gal) 4.5 kg (2.4 L)	7.5 lbs (0.50 gal) 3.4 kg (1.9 L)

Overview, continued

Features

- Slow-growth, pure lead grid
- Patented, life-increasing grid geometry
- Water-impermeable, PVC jar
- Unique, high-strength jar-to-cover seal (bond strength >1000 lbs per linear inch of seal)
- Patented, leak-preventing post seal incorporates epoxy sleeve, rubber boot, and patented tin-alloy
- Unique, transparent circular jar
- Nonconductive, acid-resistant, polyester-glass stand

Benefits

- **Extended life:**
 - Unique grid design results in a cell capacity that actually increases with age during float service. After 15 years of service, Round Cells have a capacity greater than when originally installed.
 - Cell lifetime exceeds any other battery available today.
 - No derating is required (20% derating typically required for most other batteries).
- **Minimal maintenance:**
 - 10- or 15-year intervals between water supplements
 - Leak-free history of nearly a million installations over 25 years
 - cursory inspections recommended for cleanliness and corrosion
 - Transparency enables visual inspection for crystal growth
 - Time-consuming specific-gravity checks are eliminated
- **Safety/standards compliance:**
 - Designed to minimize the hazards of fire and electrolyte leakage
 - Flammability rating: UL94V-0, ASTM D 2863, 33% LOI
 - Seismic rating with specific Round Cell battery stand
- **Easy installation:**
 - Space-saving, lightweight polyester-glass stand snaps together
- **High reliability:**
 - Plate capacity increases over time. Jar size allows for 3% grid growth before contact, resulting in a battery life that extends well beyond 40 years when maintained properly.

Battery Stands

Design

Battery Stands are designed for use with Round Cell batteries in both non-shock/vibration locations and earthquake areas.

Construction

The polyester-glass construction of the stands makes them stronger, safer, easier to install, and more compact than metal stands.

Arrangements

The stands are available in the following arrangements, which are illustrated in Figure 2-1:

- 2-tier and 3-tier (L-1S)
- 4-tier (L-2S, L-3S, and L-4S)

Battery Stands, continued

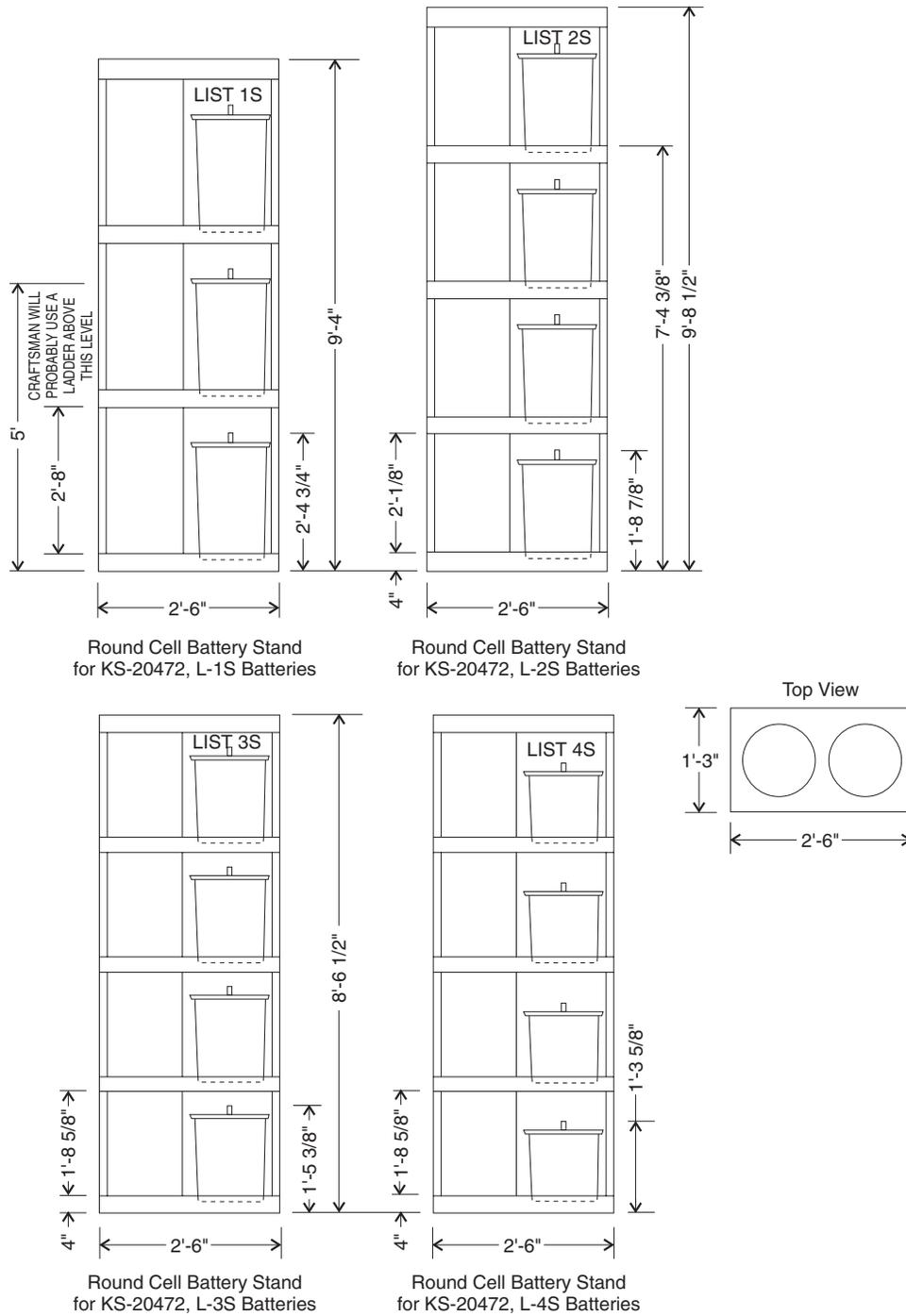


Figure 2-1: Dimensions of Battery Stands Equipped with KS-20472 Round Cells

3 *Ordering Information*

Batteries

Ordering Table

Table 3-A lists the comcodes associated with the Round Cell Battery.

The comcode is the ordering number used to purchase the product. The KS- numbers refer to the Lineage Power documents that specify the design and manufacture of each Round Cell Battery and the ancillary equipment used to install it.

Table 3-A: Round Cell Batteries Ordering Information

Comcode	KS No.	List No.	Description
402785232	KS-20472	1S	1600Ah Round Cell Battery
402785240	KS-20472	2S	864Ah Round Cell Battery
402785257	KS-20472	3S	488Ah Round Cell Battery
402785265	KS-20472	4S	296Ah Round Cell Battery
402467252	KS-22385	10	Intercell Connector (12" x 1" x 1/8")
402467245	KS-22385	1	Connector bolt
402467310	KS-22385	60	Intercell connector (UPS) (12" x 2-1/2" x 3/8")
402467864	KS-22385	50	Connector bolt (UPS)
997992615	KS-5549	1353	Thermometer
402242697	KS-5499	1306	Hydrometer
997525555	KS-5499	1303A	Hydrometer holder
406411173			Cell numbers
401710769			4/0 cable

Battery Stands

Ordering Table

Table 3-B lists the various codes associated with the Round Cell Battery Stand.

The KS- numbers refer to the Lineage Power documents that specify the design and manufacture of the battery stand equipment. The P- numbers refer to piece parts required for installation.

Table 3-B: Round Cell Battery Stand Ordering Information

Comcode	KS or P No.	List No.	Description
400771309	KS-20760	1	Back panel for KS-20472, L-1S Round Cell Battery
400771317	KS-20760	2	Back panel for KS-20472, L-2S Round Cell Battery
401512009	KS-20760	7	Back panel for KS-20472, L-3S and L-4S Round Cell Batteries
400773867	KS-20760	5	Base for all Round Cell Batteries
400770558	KS-20760	6	Dovetail key for interlocking bases
401864574	KS-21724	4	Cable guard
401856067	KS-21723	1	Cable bracket
841657166	--	--	Auxiliary framing support
841064793	--	--	Hex nut (2 required with aux framing support)
814947073	P-49D707	--	Bolt (2 required with aux framing support)
801829672	P-182967	--	Lockwasher (2 required with aux framing support)
814251914	P-42E191	--	Washer (2 required with aux framing support)

Notes:

Use this table for individual units. Refer to Tables 3-C through 3-F for battery stand arrangements ordering information.

The basic battery stand module consists of the following:

- (2) KS-20760, L-5 Base
- (2) KS-20760, L-1, L-2, or L-7 Back Panel
- (4) KS-20760, L-6 Dovetail Keys for every four Round Cell Batteries

See ED-82563-10 for battery stand arrangements of the KS-20760 Battery Stand soft sites, earthquake area sites, and hardened sites.

See ED-82868-30 for battery stand arrangement of the KS-20760 Battery Stand for UPS applications.

Battery Stands, continued

**24-volt Battery
Plants**

**Table 3-C: Lists of J-Code Drawings for Battery Stand
Arrangements of 24-volt Power Battery Plants**

J-Code	Volts	Quantity		Length	Width	Per Stand		KS-20472 Lists	Type of Plant
		Tiers	Rows			Cells	Strings		
J85504A1	24V	2	1	7'6"	2'6"	24	2	L-1S	Lineage
J87123A	24V	2	1	7'6"	1'3"	12	1	L-1S L-2S L-3S L-4S	111A
J87123B	24V	2	2	3'9"	2'6"	12	1	L-1S L-2S	111A 326
J87123C	24V	2	2	8'11-3/4"	2'6"	13	1	L-1S	302
J87123D	24V	2	2	2'6"	2'6"	8	4	L-1S (EMC)	302B
J87123E	24V	2	2	7'6"	2'6"	12	2	L-1S	111A 151 152 154 326
J87123F	24V	3	2	2'6"	2'6"	12	1	L-2S L-3S L-4S	111A 132A 133B
J87123G	24V	3	1	5'0"	1'3"	12	1	L-2S	132A 133B

Battery Stands, continued

**48-volt Battery
Plants**

**Table 3-D: Lists of J-Code Drawings for Battery Stand
Arrangements of 48-volt Power Battery Plants**

J-Code	Volts	Quantity		Length	Width	Per Stand		KS-20472 Lists	Type of Plant
		Tiers	Rows			Cells	Strings		
J85504A1	48V	2	1	7'6"	2'6"	24	2	L-1S	Lineage
J87124A	48V	2	1	15'0"	1'3"	24	1	L-1S L-2S L-3S L-4S	
J87124B	48V	2	2	7'6"	2'6"	24	1	L-1S L-2S	100, 300
J87124C	48V	2	2	17'10"	2'6"	27	1	L-1S L-2S	302
J87124D	48V	2	2	15'0"	2'6"	48	2	L-1S	100, 300
J87124E	48V	2	1	15'0"	1'3"	24	1	L-1S	151A
J87124F	48V	2 2	2 2	8'9" 7'6"	2'6" 2'6"	24 24	1 1	L-1S or L-2S CEMF cell	100 and 300
J87124G	48V	3	2	5'0"	2'6"	24	1	L-1S L-2S L-3S L-4S	100
J87124H	48V	4	2	3'9"	2'6"	24	1	L-3S L-4S	100
J87124J	48V	3	2	5'0"	2'6"	24	1	L-3S or L-4S CEMF cell	100
J87124L	48V	3	1	10'0"	1'3"	24	1	L-2S, 133A	133B
J87124M	48V	2	2	2'6"	2'6"	4	1	L-1S (EMC)	302S

Battery Stands, continued

**130/140-volt
Battery Plants**

Table 3-E: Lists of J-Code Drawings for Battery Stand Arrangements of 130/140-volt Power Battery Plants

J-Code	Volts	Quantity		Length	Width	Per Stand		KS-20472 Lists	Type of Plant
		Tiers	Rows			Cells	Strings		
J87125A	140V	2	2	22'6"	2'6"	70	1	L-1S	415
J87125B	140V	3	2	15'0"	2'6"	70	1	L-1S	415
J87125C	140V	2	2	22'6"	2'6"	70	1	L-2S	415
J87126A	130V	2	2	22'6"	2'6"	69	1	L-1S L-2S	708A
J87126B	130V	3	2	13'9"	2'6"	63	1	L-3S	411
J87126C	130V	2	2	22'6"	2'6"	66	1	L-1S L-2S CEMF units	412
J87126D	130V	3	2	15'0"	2'6"	66	1	L-1S L-2S L-3S L-4S CEMF units	412
J87126E	130V	4	2	11'3"	2'6"	66	1	L-3S L-4S CEMF units	412
J87126F	130V	2	2	22'6"	2'6"	69	1	L-1S L-2S 702C	708C
J87126G	130V	3	2	15'0"	2'6"	69	1	L-1S L-2S L-3S L-4S	702C, 708A
J87126H	130V	4	2	11'3"	2'6"	69	1	L-3S L-4S	702C

Note: Use J85504A, ED-82868-30, and ED-82563-10 as guides to order self-configured battery stands.

Battery Stands, continued

**10 P.S.I.
Earthquake
Bracing**

Table 3-F: List of J-Code Drawings for 10 P.S.I. Earthquake Bracing Battery Stand Arrangements

J-Code	Volts	Quantity		Includes Space for Earthquake Bracing and 10 P.S.I. Bracing Material		Per Stand		KS-20472 Lists	Type of Plant
		Tiers	Rows	Length	Width	Cells	Strings		
J85504A	24V	2	2	7'10-1/2"	2'10-1/2"	24	2	L-1S	Lineage
	48V	2	2	7'10-1/2"	2'10-1/2"	24	1	L-1S	Lineage
J87127A	24V	2	2	4'1-1/2"	2'10-1/2"	12	1	L-1S	100
J87127B	24V	2	2	7'10-1/2"	2'10-1/2"	24	2	L-1S	100, 326
J87128A	48V	2	2	7'10-1/2"	2'10-1/2"	24	1	L-1S	100
J87128B	48V	2	2	15'4-1/2"	2'10-1/2"	48	2	L-1S	326
J87128C	48V	2	1	15'4-1/2"	2'10-1/2"	24	1	L-1S	151A
J87130A	140V	2	2	11'10-1/2"	2'10-1/2"	70	1	L-1S L-2S	413A, 415A

Notes:

For hardened 50 P.S.I. sites, use J87131A, and J87131B drawings for battery stand, bracing material, and shock isolation platform.

For other voltages, use J85504A, J87131A, and J87131B as guides to assemble the battery stand with bracing material and shock isolation platform.

Battery Stands, continued

**Earthquake
Bracing of
KS-20760 Battery
Stands**

**Table 3-G: Guidelines for Earthquake Bracing
of KS-20760 Battery Stands**

Battery Stand Arrangement for All KS-20472 Batteries (Note 1)	Earthquake Zones					
	1		2		3	4
	Ground Floor and 1st Floor	Above 1st Floor	Ground Floor and 1st Floor	Above 1st Floor	All Floors	All Floors
1-Tier 2-Row	NR		EQS (Note 7)			
2-Tier 1-Row	EQS (Note 2)	EQS (Notes 5, 6)			EQS (Notes 4, 5, 9)	
2-Tier 2-Row	NR		EQS (Note 7)	EQS (Note 5)		EQS (Notes 5, 6)
3-Tier 1-Row	EQS (Notes 2, 4)	EQS (Notes 3, 5, 6)			R	
3-Tier 2-Row	NR	EQS (Note 5)	EQS (Notes 7, 8)	EQS (Notes 5, 6)	EQS (Notes 3, 5, 6)	
4-Tier 1-Row	EQS (Notes 2, 4)	EQS (Notes 4, 5)		EQS (Notes 4, 5, 9)	R	
4-Tier 2-Row	NR (Note 3)	EQS (Notes 3, 5)		EQS (Notes 3, 5, 6)	EQS (Notes 4, 5, 9)	R
<p>Key: NR = No requirements for earthquake bracing. R = Restricted. DO NOT USE in designated earthquake zones. EQS = Earthquake modifications per KS-20760 arranged per ED-82563.</p> <p>Notes: 1. KS-20472 Round Cells Only. 2. Attach to building wall per ED-82563-10. 3. Applies to KS-20472, List 2S, 3S, and 4S only. Do not use List 1S. 4. Applies to KS-20472, List 3S and 4S only. Do not use List 1S and 2S. 5. Earthquake hold-down assembly required. 6. Joints must be epoxied if KS-20472, List 1S or 2S cells are used. 7. Steel Base retainers required. 8. Earthquake hold-down assembly required for KS-20472, List 1S and 2S. 9. Joints must be epoxied.</p>						

4

Safety

Introduction

Read and understand this section thoroughly before moving, unpacking, installing, or maintaining Round Cell batteries. Fully brief anyone with access to battery areas, or who are working near or with batteries, on the hazards associated with lead-acid batteries.

Follow the procedures noted in the *Battery Storage* and *Installation* sections.

Additional information that everyone needs to understand before having access to the batteries can be found in the Material Safety Data Sheet (MSDS) in Section 10 of this product manual. The MSDS includes health hazard summaries, first aid procedures, fire and explosion hazard data, reactivity data, special protection information, environmental information (spill clean-up and disposal), and special precautions.

Safety Symbols



Admonitions

DANGER indicates the presence of an imminently hazardous situation that *will* cause death or severe personal injury if the hazard is not avoided.

WARNING indicates the presence of a potentially hazardous situation that *can* cause death or severe personal injury if the hazard is not avoided.

CAUTION indicates the presence of a hazard that *will* or *can* cause minor personal injury or property damage if the hazard is not avoided.

NOTE or **NOTICE** indicates instructions that need to be followed for correct use and/or to minimize the chance of equipment damage.

Poison

Lead-acid batteries contain electrolyte (sulfuric acid and water), a highly corrosive substance. It is possible that certain types of physical damage and/or abusive charging may force electrolyte outside the battery container.

**POISON
CAUSES SEVERE BURNS**

Lead-acid batteries contain toxic materials (lead, lead compounds, and sulfuric acid). Do not incinerate or mutilate. Avoid contact with skin, eyes, or clothing. Recycle batteries in approved reclamation centers according to local, state, and federal regulations.

- When handling batteries or cells, wear protective equipment (e.g., acid-resistant rubber gloves, acid-resistant rubber aprons, and impact-resistant, splash-proof goggles or full face mask).
- Even when not handling batteries, as a minimum protection wear splash-proof and impact-resistant goggles while working around batteries or on equipment containing batteries.
- Never tip a cell more than 25 degrees or electrolyte may spill through the vent.

The following items can be ordered from Lineage Power. These items should be made available to anyone working around batteries. The local, state, or federal codes for certain installations may require some of these items to be installed and/or kept at the installation site.

- Protective gear
- Battery cleaning and maintenance kits
- Acid spill clean-up kit
- Acid Spill Management System

Electrical Hazard

Batteries differ from other sources of power in that they are delivered to the points of installation as live units. A battery gives no indication by its appearance of the potential energy stored in it. Batteries have enormous short circuit capability that can result in serious burns or create dangerous projectiles from the object causing the short circuit. Even a single battery poses a potentially high energy hazard if shorted. Shorting a battery may result in explosion of the battery, injury to personnel, and damage to equipment. A tool or other metal object causing the short may be thrown or vaporized due to the energy produced by the battery or system.

WARNING ELECTRICAL HAZARD

In addition to proper job training and safety procedures, the following are some basic precautions that should always be followed when working with or around batteries (including equipment connected to batteries):

- Always use insulated tools.
- Never place uninsulated metal objects on top of a battery.
- Remove all metal jewelry, such as rings, watches, bracelets, necklaces, and other metallic items.
- Do not short circuit the battery.
- Ensure proper polarity when making connections.
- Wear non-conductive eye protection.
- Remove items that could fall out of clothing pockets.
- Personnel with implanted electronic medical devices need to be aware of their restrictions when working around electricity.

***Electrical
Hazard,
continued***

- Exercise extreme care to avoid any short circuits across the battery terminals.
- In a grounded battery system, use extreme care not to short any metal objects from the ungrounded battery terminal to ground (which can include the equipment metal chassis, building structure, cable racks, etc.).
- If Round Cells are used on metal stands, install nonconducting mats between the battery and the shelf.
- Electricity produces magnetic fields that can affect implanted electronic devices. The strength of the magnetic field depends on the amount of current in the circuit, as well as other conditions (such as: number of conductors, placement, and distance from the conductor). DC power and distribution systems, including the batteries, that are typically used in telecommunication utility rooms can operate at high current levels. Personnel with electronic medical devices need to be aware of their restrictions when working around electricity.

Shock Hazard

A single cell is typically at low voltage; however, cells connected together in a system can pose a shock hazard in addition to an energy hazard.

- When interconnection of the cells creates a hazardous voltage supply, post appropriate warnings in the end systems or installations.
- For all systems and/or installations, use additional markings based on the use of the battery, industry standards, and local, state, and federal regulations.

Battery Gases

Lead-acid batteries produce hydrogen gas even under normal charging and open circuit conditions. Boost charging or abnormal conditions, such as high temperature, abnormal charging, shorted cells, etc., can produce greater amounts of gas. If not permitted to escape, this gas can build up to explosive concentrations.

DANGER!
RISK OF EXPLOSION

- Battery gases are explosive. Do not allow sparks or open flame near batteries.
 - Do not smoke around batteries.
 - Never charge batteries without vent funnel in place.
 - Do not handle, move, or work around batteries during or for 48 hours after charging at a voltage greater than 2.20V/cell.
 - Handle, move, or store charged cells only with vent funnel (NOT orange shipping plug) in place.
 - If the orange shipping plug must be reinstalled for transportation, let the battery sit for an additional 24 hours at open circuit after the 48-hour float charge (less than 2.20 volts/cell) before removing the vent funnel and replacing it with the orange shipping plug.
 - Do not allow gas vents to become clogged or an explosion due to internal pressure may result.
 - Properly ventilate battery area.
 - Do not place batteries in a sealed enclosure/room.
-
- Make sure the area is properly ventilated and the batteries have been on a float charge at a voltage less than 2.20 volts/cell for at least 48 hours before performing any work around the battery. If working around or with batteries in an area that may not have sufficient air movement, provide more air movement (for example, by using a portable fan placed at a safe distance from the batteries).
 - ALWAYS place batteries in a well-ventilated area.
 - NEVER place batteries in a sealed enclosure. Even enclosures/rooms with ventilation need to be properly evaluated to assure hydrogen will not accumulate to explosive levels.

Battery Gases, continued

- Since gas generated by batteries is explosive, avoid any activity that could ignite the gas (especially in the area of the vents). Some examples of possible ignition sources that must be avoided are sparks (including those from static electricity or from making/breaking electrical connections), open flame, smoking, and any tools/appliances that may generate sparks, e.g., motors.
- Before performing any work operation, follow proper ESD protection procedures to discharge the static electricity from your body.
- Never tamper with or block the vents of batteries. Damaged or clogged vents may result in an explosion due to excessive internal pressure. Such an explosion could short circuit other battery modules, result in a fire, injure personnel, or cause damage to equipment.
- Never charge a battery that is visibly damaged or frozen (typically at temperatures less than -40°C or -40°F).
- Do not disconnect the circuit at the battery terminals while the battery is being discharged or charged.
- Isolate the battery string from any power source or load before making or removing connections at the battery terminals. If there are no devices (fuses, circuit breakers, or disconnect switches) for opening the circuit, here are some suggested procedures:
 - Make sure the free end of any wire to be connected to the batteries is insulated until it is ready to be connected to the load or charger or immediately after being disconnected from the load or charger.
 - Connect to the battery terminals first before connecting to the load or charging system.
 - Disconnect at the load or charger first before disconnecting at the battery terminals.

Note: Lineage Power recommends not making connections to the battery terminals while the circuit is attached to a power source or load. However, some circumstances may require personnel to replace cells within a string while the string is still connected to the load/charger to avoid interruption of service. If this situation occurs, refer to Section 7, “Replace a Cell in an Existing String,” for a suggested procedure that will minimize the risk.

Vent Funnel and Orange Shipping Plug

These guidelines cover the proper use of the orange shipping plug and vent funnel.

**DANGER
RISK OF EXPLOSION**

The vent funnel and orange shipping plug must be used properly to reduce the risk of explosion. Improper use could increase the risk of explosion due to concentrations of hydrogen gas around the vents, or excessive internal pressure.

- The orange shipping plug is used for transportation. It is provided with a small opening to allow some hydrogen gas to escape and to minimize the spill of electrolyte. The opening is sized to allow the minor amounts of hydrogen to escape that can exist under open circuit. **It WILL NOT provide sufficient ventilation or dispersing of gas from the battery under ANY charging conditions.**
 - DO NOT charge battery with orange shipping plug in place.
 - DO NOT remove vent funnel and replace with the orange shipping plug UNLESS the battery has been on float charge at a voltage less than 2.20 volts/cell for at least 48 hours, and let sit at open circuit for an additional 24 hours.
- The vent funnel must be in place before applying ANY charge. Once the battery is in place, remove the orange shipping plug and insert the vent funnel. The vent funnel is designed to ventilate the hydrogen gas from the battery by dispersing the gas through many pores around the vent. Dispersing the gas helps reduce the risk of explosion. However, applying a charge greater than the float voltage creates additional gas around the vent funnel that increases the risk of explosion.
 - Seat vent funnel properly.
 - ALWAYS let the battery sit for at least 48 hours at a voltage less than the float voltage of 2.20 volts/cell before doing any work around the battery. It is important that the voltage is verified to be less than the recommended float voltage.
 - DO NOT handle or work around batteries while charging at greater than the recommended float voltage.

Warning Signs

To direct attention to the possible sources of danger, post one or more warning signs, lettered in large characters, in a conspicuous location near the batteries.

The warning signs are not meant to be a replacement for proper job procedures and training. All information noted in this section is important and must be understood by anyone working around or handling batteries. A warning sign should serve as a strong reminder.

The following example lists the type of information that should be given:

<p style="text-align: center;">DANGER! RISK OF EXPLOSION</p> <ul style="list-style-type: none">• Battery gases are explosive. Do not allow sparks or open flame near batteries.• Do not smoke around batteries.• Never charge batteries without vent funnel in place.• Do not handle, move, or work around batteries during or for 48 hours after charging at a voltage greater than 2.20V/cell.• Handle, move, or store charged cells only with vent funnel (NOT orange shipping plug) in place.• If the orange shipping plug must be reinstalled for transportation, let the battery sit for an additional 24 hours at open circuit after the 48-hour float charge (less than 2.20 volts/cell) before removing the vent funnel and replacing it with the orange shipping plug.• Do not allow gas vents to become clogged or an explosion due to internal pressure may result.• Properly ventilate battery area.• Do not place batteries in a sealed enclosure/room.

Separate warning signs that alert personnel to electrical hazards and the hazards of electrolyte should also be considered.

Additional Information

First Aid

Refer to the MSDS in Section 10 for first aid procedures.

Transportation

New batteries are shipped meeting United Nations standard, DOT, IATA, IMDG, and other State and Government regulations.

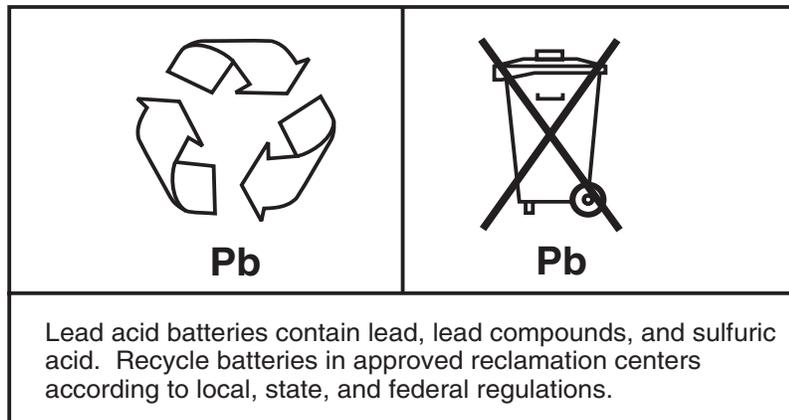
Handling

Refer to “Unpacking and Handling” in the *Installation* section of this product manual for specific handling instructions.

Environmental

Old/used batteries should be considered as Hazardous Waste and transported according to respective DOT, EPA, OSHA, and other governing regulations or guidelines for Hazardous Waste.

Do not discard batteries in trash cans.



5 *Battery Storage*

Overview

State of New Battery

The Round Cell battery is shipped charged and wet. The open circuit voltage for a Round Cell battery is approximately 2.06V/cell.

Storage Conditions

- Store batteries in an upright position in a dry and cool environment without exposure to direct sunlight.
- Provide adequate ventilation during storage.
- Do not stack pallets of batteries on top of each other.

Storage Time

Batteries may suffer irreversible capacity loss if left on open circuit for long periods of time. The maximum that a charged battery may remain on open circuit is 6 months at 77°F. The open circuit time should not exceed 4 months if the storage temperature exceeds 90°F. The “charge by” date stamped on the shipping container is the date the battery has been on open circuit for 6 months. If batteries cannot be installed within this time period, refer to Section 6, “Maximum Time Allowable Until Initial Charge.”

**DANGER
RISK OF EXPLOSION**

- Only qualified, trained personnel who have read and understand the safety section of this manual should perform maintenance work on Round Cell batteries.
- Do not charge a Round Cell battery with the orange shipping plug in place. Refer to the procedures in Section 6, *Installation*.

6 *Installation*

Introduction

In This Section

This section describes the procedures for installing the Round Cell batteries. **Please read the safety statements and precautions in Section 4 before unpacking and installing the batteries.**

Installation Tools, Materials, and Test Equipment

Use the following tools, materials, and test equipment for installing and testing the Round Cells:

- Protective clothing and equipment:
 - rubber gloves, apron, and overshoes
 - impact-resistant, splash-proof goggles or full-face mask
 - safety hard hat
- Hoist and battery lifting clamp
- Gantry extension (required for 3-tier arrangements)
- Flashlight with plastic or rubber housing
- Cleaning cloth
- Soda (sodium bicarbonate or sal soda) and/or lime to neutralize spilled electrolyte
- Eyewash kit (KS-21527, L3)
- Eyewash solution (KS-21527, L4)
- Insulated torque wrench capable of measuring 150 inch-pounds
- Insulated 1/2-inch box wrench
- 3-inch and 6-inch wrench extensions
- Hydrometer (range 1.150 to 1.240) (KS-5499 List 1306)
- Thermometer (KS-5499 List 1352, List 1353)
- Sandpaper
- Small, stiff brush
- DMM (Digital Multimeter) with an accuracy of 0.02 percent on the dc scale
- A dc power source capable of supplying 2.55 volts per cell and a current capability of at least 10 amperes

Unpacking and Handling

Guidelines

- Protect personnel and equipment by using the proper material handling equipment.
- Move packaged batteries to a convenient predetermined area where the appropriate unpacking and handling equipment and tools are available.
- If possible, inspect each cell package visually for shipping damage before it is completely unpacked. If it is determined that the cell should be returned to the manufacturer, it will be easier to return it at this point than after the cell has been completely unpacked.
- Note the charge-by date on the shipping container.

Specific Unpacking Instructions

Specific Unpacking Instructions	
Step	Action
1	Examine the shipping container and record any signs of external damage.
2	Search for indications of spillage during shipment. If found, record indications on the bill of lading before signing. Note: Spillage is a valid criterion for rejection of product.
3	If the spillage is large, use agricultural or industrial lime instead of soda for neutralization before cleanup. Sprinkle the lime on the spillage and allow it to absorb the electrolyte. Warning Wear personal protective clothing and equipment when using lime on electrolyte spills. Wash hands and face thoroughly after use.
4	After the lime has absorbed all the electrolyte, sweep it up and dispose of it in accordance with local, state, and federal regulations. Note: The absorbed electrolyte is considered to be Hazardous Waste and must be disposed of according to local, state, and federal regulations.
<i>Continued on next page.</i>	

Unpacking and Handling, continued

Specific Unpacking Instruction, continued	
Step	Action
5	<p>Round Cells that are shipped on a pallet should be left on the pallet until their final location is reached. However, the cell may be cut loose from the pallet and handled individually if necessary.</p> <p style="text-align: center;">Caution Do not tip cells more than 25 degrees to prevent electrolyte spillage through the vent.</p>
6	<p>Unpack the vent funnels and store in a convenient protected location until final tightening of intercell connectors is completed. See “Vent Funnel Installation and Disposition of Vent Plugs.”</p>
7	<p>After unpacking, immediately check the electrolyte level of the cells.</p> <ul style="list-style-type: none"> • If the electrolyte level is below the point at which the plastic cap is attached to the negative post, or below any cell plate, the battery is not acceptable for installation because excessive spillage is indicated. • If the electrolyte level 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-level mark on the battery jar.
8	<p>Measure and record the specific gravity before the cell is hoisted into place. The specific gravity of installed and charged cells should be 1.215 ±0.005.</p> <p>Note: Refer to “Electrolyte Levels” in this section for more information.</p>
9	<p>If it becomes necessary to return any filled cell to the manufacturer because of low electrolyte level, add 1.215 ±0.005 specific gravity electrolyte immediately, if available; otherwise, add enough distilled or deionized water before shipment to bring electrolyte level to minimum. Note action taken in report to manufacturer.</p>

Unpacking and Handling, continued

Cleaning Jars

If the jar is dirty when removed from the shipping container, clean the jar with a cloth dampened in clean water before installing in the rack.

Note

Use only water to clean jars.

Cleaning Posts

Round Cells are shipped with the posts coated with NO-OX-ID A[®] (regular or special) compound. If the posts have come in contact with acid due to electrolyte spillage, clean them as follows:

Cleaning Posts	
Step	Action
1	Remove the NO-OX-ID A [®] (regular or special) compound by wiping with a dry cloth.
2	Neutralize the posts with a weak soda solution.
3	Wipe the neutralized surfaces with a cloth dampened in clean water.
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.

Unpacking and Handling, continued

Lifting Clamp

Caution

Do not lift the cell by the terminal posts or damage to the cell may result.

The jar cover on the Round Cell is designed with a lip for lifting purposes. A special lifting clamp is available specifically for grasping the cell. The clamp lifts the cell by the lip of the jar cover in an action similar to that of ice tongs.

A conventional hoist (gantry) with a hook to engage the special clamp may be used for installing Round Cells on battery stands

Warning

- When lifting the Round Cell battery using the lifting clamp, center the clamp over the battery. See Figure 6-1.
- To avoid injury and/or battery damage:
 - When operating the hoist and clamp to position a battery, do not bump or push on the battery. This may push the battery out of the clamp.
 - To move the battery, direct the travel of the battery in the direction of the axis of the clamp.
 - To position the battery, push on the clamp in the direction of the axis of the clamp, or use a hoist to position battery.

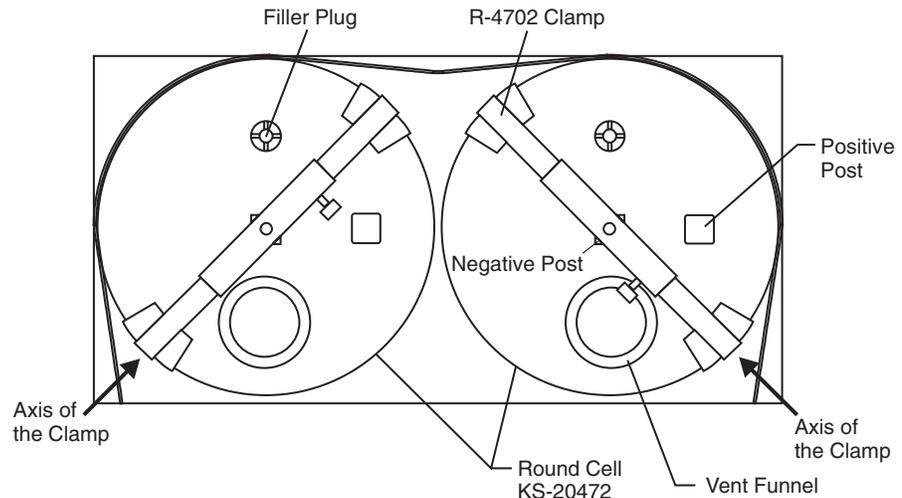


Figure 6-1: Lifting Clamp

Installation Guidelines

Location

Lineage Power generally recommends that the Round Cells be mounted on polyester battery stands. See Figure 6-2. However, for soft-site locations and earthquake sites that already have conventional metal battery stands, the List 1S Round Cell can be used to replace the 1680AH rectangular cells on a one-string-to-one-string basis. This also applies to List 2S cells replacing 840AH rectangular cells in standard arrangements. For soft-site applications of List 3S or List 4S cells, Lineage Power that the polyester stands be used for space economy.

Note

For Earthquake Zone 4, List 1S Round Cells are limited to stands two tiers high.
--



Figure 6-2: KS-20472 Round Cell Installation

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 multi-tiered stands, building maintenance should provide shields for the radiators, blinds for the windows, or special ventilation for the multi-tiered stands to provide less than a 5°F (2.8°C) temperature variation anywhere in a string.

Installation Guidelines, continued

Battery Stands

The battery stands are assembled from three major parts: the bases, back panels, and dovetail keys. (See Figure 6-3.)

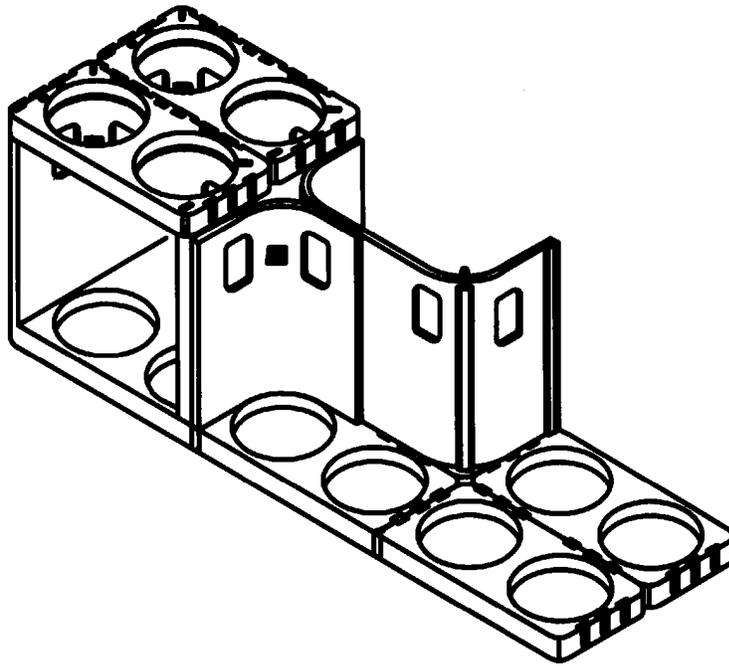


Figure 6-3: Polyester Battery Stand Bases, Backs, and Dovetail Keys

These parts are molded 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 back panels, and provides mounting space for four cells. The backs are available in three different heights to accommodate the four cell sizes.

The module is assembled by inserting the back panels into the base cavity. Panels are cemented into the base cavities for hardened-site and some earthquake applications using RTV silicone cement.

Caution

The RTV (Room Temperature Vulcanized) silicone cement is mildly toxic until cured and should be applied in a well-ventilated working area.

Installation Guidelines, continued

Bases and Cable Guards

Bases are fastened together by inserting a plastic dovetail key into the cavity formed by two adjoining base shelves. The modules can be combined to provide as many mounting positions as needed, and cable guards can be assembled directly to the stands. See Figure 6-4.

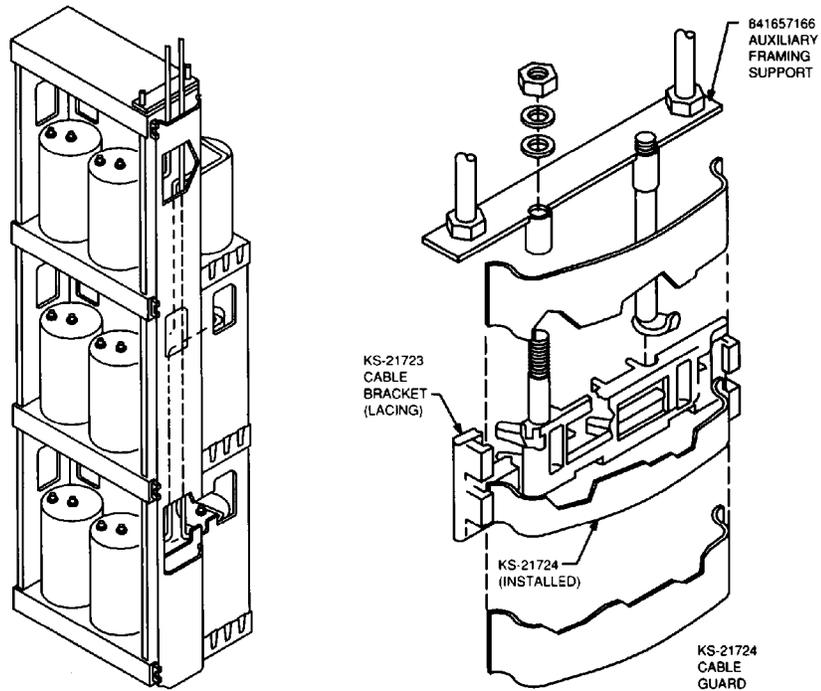


Figure 6-4: Typical Method of Supporting Cable Guard and Equipment on Top of a Round Cell Battery Stand

Installation Guidelines, continued

Soft Site Installations

For soft-site installations, the stands can be arranged as follows:

- free-standing 4-tier, 2-row (except with List 1S cells)
- free-standing 3-tier, 2-row
- free-standing 2-tier, 2-row
- 2-tier, single-row for mounting against a wall

Additional bracing is required for earthquake and hardened-site installations. Figure 6-5 shows an array of stands with earthquake braces installed. (Consult your Lineage Power Account Representative for additional information.)

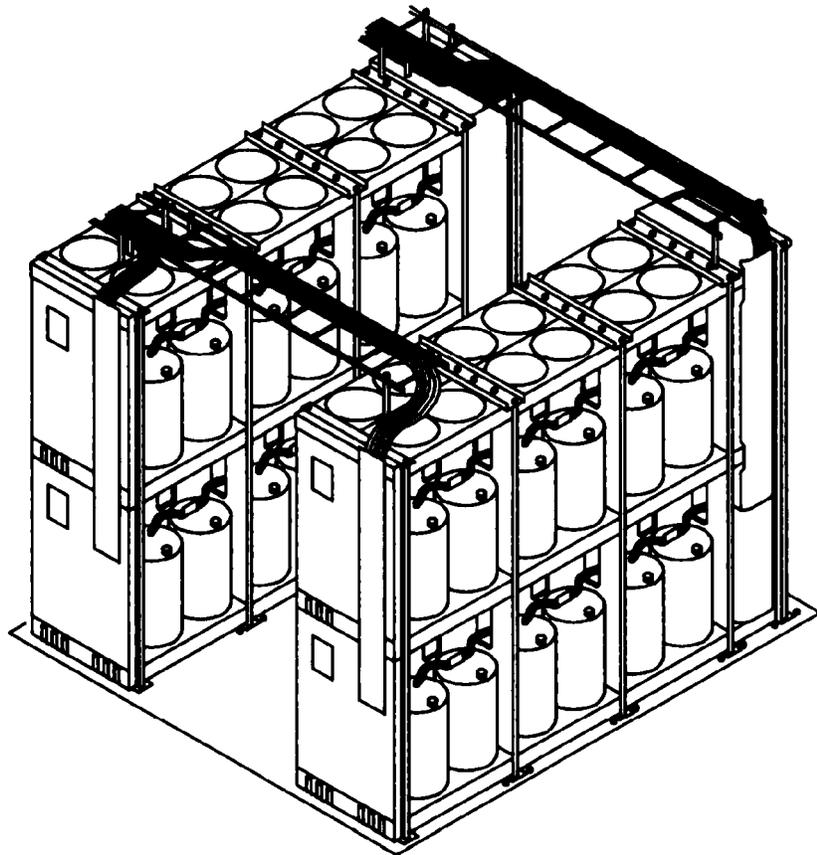


Figure 6-5: Battery Stands Showing Earthquake Bracing and Cable Routing

Orienting and Spacing Cells in Stands

Guidelines

- New Round Cells may be intermixed directly into an existing string of older Round Cells (of the same capacity and acid specific gravity) when necessary for replacement purposes.
- Never mix Round Cells in the same string with rectangular cells.
- Never mix different AH-rated Round Cells in the same string.
- Strings of Round Cells can be used in parallel with strings of rectangular cells, providing the acid specific gravities are the same.

Caution

If Round Cells are used on metal stands, install nonconducting mats between the battery and the shelf.

DANGER

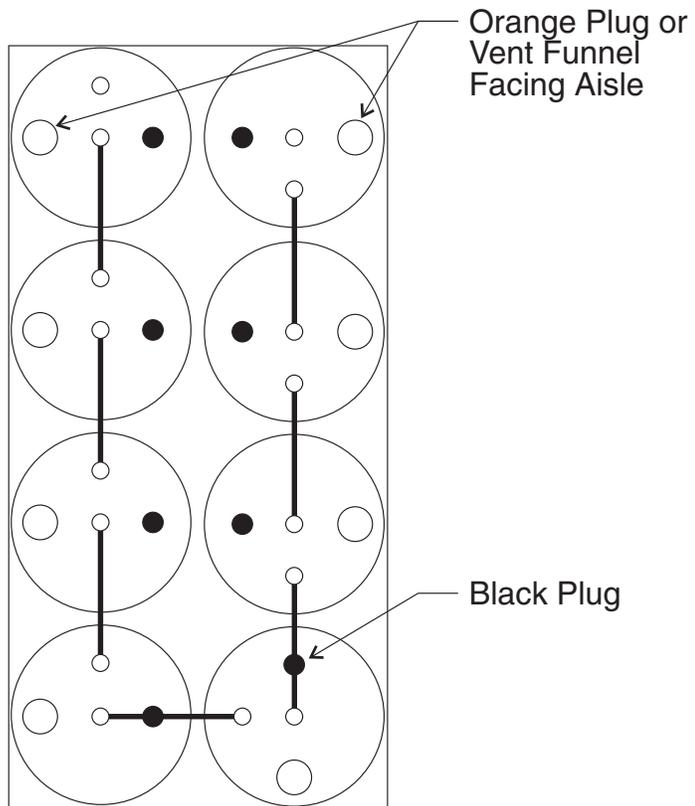
If Round Cells have already received an initial charge, do not place in stands or orient cells without vent funnel. **Do not use orange shipping plug.**

- Nonconducting mats are not required when the Round Cell is positioned on polyester battery stands. The space between Round Cells is 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 intercell connectors. **Never allow the cell jars to touch.** Cell spacing should be checked after each earthquake or severe shock.
- Spacing between rows on metal stands should be 3/4 inch minimum. For the polyester stands, the spacing between rows is fixed by the stand design.

Orienting and Spacing Cells in Stands, continued

Black and Orange Plugs

The Round Cell is shipped with two types of plugs installed. The black plug is solid and the orange shipping plug is vented. After unpacking, orient the cell on the stand for proper polarity (see Figure 6-6). 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. In some arrangements, the cell orientation will not allow removal of the black plug after the intercell connectors are installed (see Figure 6-6). This is not a problem since removal of this plug is not required or recommended during normal maintenance.



Orange plug must be removed and vent funnel installed before initial charge.

Figure 6-6: Round Cell Orientation

Orienting and Spacing Cells in Stands, continued

Temperature Reference Cell Selection

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

Intercell Connection

- For cells utilizing only two intercell connectors, use the lowermost mounting holes.
- Do not abrade, i.e., file, scrape, or sand, battery intercell connectors, or brush them with a wire brush; this will remove the protective lead coating. It is not necessary to wipe the ends of the intercell connectors before installing them.
- To make intercell connections, use wrenches with insulated handles to prevent the possibility of shorting cells.
- Do not install the final links to connect the battery to the power plant until the battery is ready to be charged.

Intercell Connection	
Step	Action
1	Apply NO-OX-ID A [®] (regular or special) compound to the intercell connectors, using a small stiff brush to coat all contact surfaces between the post and intercell connector.
2	Apply NO-OX-ID A [®] compound to threads of connector bolts and nuts.
3	Using a wrench with an insulated handle, tighten connections to 150 inch-pounds. <p style="text-align: center;">Caution Do not over-tighten connectors. This may cause the posts to break.</p>
4	Verify that all connections have been tightened.
5	After making all connections, wipe off excess compound with a cleaning cloth.

Vent Funnel Installation and Disposition of Vent Plugs

Procedure

DANGER

- Vent funnels with cracks, breaks, or other defects in the bayonet or funnel stem below the gasket may increase the risk of explosion during initial or boost charging above 2.30 volts. Replace defective funnels before charging the cell.
- Insure that the tip of the funnel is completely submerged below the electrolyte level to reduce the risk of explosion.

Vent Funnel Installation and Disposition of Vent Plugs	
Step	Action
1	Before initial charging, install the vent funnel in place of the orange plug.
2	Rinse the orange plug in water before disposal.
3	Carefully examine the vent funnels for defects. If a defect is noted, install a new vent funnel as soon as possible.

Hydrometers

Assembling the Hydrometer

Caution

To avoid possible serious cuts from broken glass, wear rubber gloves and use extreme care in assembling the hydrometer syringe. If the hydrometer has previously been used and may possibly contain some electrolyte clinging to the wall, use goggles in assembly operations to protect the eyes.

Note

To avoid electrolyte contamination, hydrometers used in lead-calcium or lead-antimony cells should not be used in the Round Cell.

Assembling the Hydrometer	
Step	Action
1	Remove any mold seam flash from the rubber parts that fit against the glass barrel.
2	Wrap several thicknesses of heavy cloth around the glass barrel to protect the hands.
3	Use water to wet the rubber parts and the glass barrel before assembly operations.
4	Fit the rubber parts to the glass barrel.

Flexible Tube Length Determination

Flexible Tube Length Determination	
Step	Action
1	Fit the flexible tube supplied in the hydrometer kit on the end of the Z-shaped hard rubber tube.
2	Cut off the end of the flexible extension so that it extends a minimum of 1/2 inch below the low-level line.

Specific Gravity Readings

Procedure

Caution

When taking specific gravity readings, cover the bottom of the tube on the hydrometer with a paper towel while moving it from cell to cell to avoid splashing or throwing the electrolyte.
--

Specific Gravity Reading	
Step	Action
1	Insert the hydrometer tube into the cell through the vent funnel. Note: Be sure that the top of the hydrometer float does not touch the stop in the hydrometer bulb since this would cause an erroneous reading.
2	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.

Initial Charging

Overview

The initial charge compensates for the self-discharge that takes place in the interval between cell manufacture and installation. The initial charge voltage should be in the range of 2.5 and 2.55 volts per cell.

DANGER!
RISK OF EXPLOSION

- Battery gases are explosive. Do not allow sparks or open flame near batteries.
- Do not smoke around batteries.
- Never charge batteries without vent funnel in place.
- Do not handle, move, or work around batteries during or for 48 hours after charging at a voltage greater than 2.20V/cell.
- Handle, move, or store charged cells only with vent funnel (NOT orange shipping plug) in place.
- If the orange shipping plug must be reinstalled for transportation, let the battery sit for an additional 24 hours at open circuit after the 48-hour float charge (less than 2.20 volts/cell) before removing the vent funnel and replacing it with the orange shipping plug.
- Do not allow gas vents to become clogged or an explosion due to internal pressure may result.
- Properly ventilate battery area.
- Do not place batteries in a sealed enclosure/room.

Initial Charging, continued

Overview, continued

In order to minimize handling and risk of explosion, it is recommended to perform the initial charge after the batteries have been installed in the stand, with the electrical connections made for the final string configuration, and the vent funnels in place.

If the batteries cannot be charged in the final installation, it is recommended to at least transport the batteries to an area where the batteries can later be moved to the final installation with the vent funnel in place. The string should be divided into groups not to exceed 60 cells for initial charge. The charger should be capable of providing 5 amperes per string.

The initial charge voltage should be between 2.5 and 2.55 volts per cell average. Charging should be continued for the number of hours indicated in Table 6-A 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 “Temperature Reference Cell Selection.”

When a lead-acid storage cell discharges, visible crystals of lead sulfate form on the positive plate. Identify the crystals on the cell before the initial charge so that their absence is apparent after the procedure is completed. Hold a flashlight close to the jar wall at an angle of approximately 45 degrees. The lead-sulfate crystals appear as sparkling diamond-like reflecting particles or as a gray coloration.

Initial Charging, continued

Maximum Time Allowable Until Initial Charge

The Round Cell is shipped charged and wet. A charged and wet cell should not stand on open circuit for more than 6 months at 77°F. The “charge by” date stamped on the shipping container is that date when the cells will be on open circuit for 6 months.

Notes

- If the storage temperature exceeds 90°F (32°C), the open circuit time should not exceed 4 months.
- If the initial charge cannot be given within 6 months, unpack the battery following the appropriate procedures in the “Unpacking and Handling” section. If the batteries are to be shipped to another location later, keep and reuse the packaging to properly prepare the battery for shipping.

DANGER

- Batteries must only be charged with vent funnel installed.
- Only qualified trained personnel that have read and understand the hazards described in the safety section of this manual should perform this work.

To maintain the battery until the normal charge can be administered, do one of the following:

- Keep the battery on continuous float charge at 2.17-2.20V/cell.
- Charge at 2.17-2.20V/cell, 8 hours a day, 5 days a week.
- 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.

Initial Charging, continued

Total Hours of Initial Charge

Table 6-A: Total Hours of Initial Charge at 2.5 to 2.55 Volts Per Cell

Time on Open Circuit	Cell Temperature**		
	81°F (27.22°C) and Above	65° to 80°F (18.33° to 26.66°C)	64°F (17.77°C) and Less
Less than 4 Months	100 Hours	150 Hours	200 Hours
More than 4 Months	150 Hours	200 Hours	250 Hours
*Time on open circuit is to be determined from the “charge by” date on the shipping container. The “charge by” date is the date when the open circuit time will be 6 months. **Cell temperature of the Temperature Reference Cell.			

Note

While on initial charge, the electrolyte level will rise substantially (about 1 inch). 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 2.17-2.20V/cell for an extended period of time.

Initial Charge Rectifier

Often the plant rectifier which will be used to float a new battery is unavailable for initial charging. In such a case, use any constant voltage dc power supply that can supply 2.55 volts per cell and 5 amperes per string (parallel string charging). For example, 24 cells can be charged by a 30-volt/10-ampere rectifier by forming two parallel strings of 12 cells each:

(12 X 2.5 = 30V, 2 strings X 5 amps each = 10 amps).

The initial charge can go unattended provided the rectifier is reliable and can remain across the cells in case of an ac power failure. Before leaving the string unattended, install a fuse with an amperage rating equal to ten times the number of strings in the rectifier’s output leads. Take individual cell readings to be sure that the cells are charging, i.e., greater than 2.3 volts per cell and within 50 millivolts of each other.

Initial Charging, continued

Before Stopping the Initial Charge

Before stopping the initial charge, record the following:

- Total hours of charge
- Temperature of the temperature reference cell in each tier of each battery string
- Presence or absence of lead-sulfate crystals for each cell.

After End of Initial Charge

At the end of initial charge, place the battery on continuous uninterrupted recommended float voltage at 2.17-2.20V/cell. Do not leave the battery on open circuit for more than 72 hours. A battery that is left on open circuit for more than 72 hours after initial charge and/or develops lead-sulfate crystals must be boost charged at 2.5 volts per cell for at least 8 hours or until crystal free before being returned to continuous float.

DANGER RISK OF EXPLOSION

- Round Cells that have received the initial charge in other than the actual installation and will be moved to the installation site must be left at float charge less than 2.20 volts/cell for at least 48 hours before handling.
- Vent funnel must be left in place.
- If the battery must be shipped/transported to another location and the orange shipping plug needs to be installed, then the Round Cell must be left on open circuit an additional 24 hours after the 48-hour float charge of less than 2.20 volts/cell before removing the vent funnel and inserting the orange shipping plug.

Initial Charging, continued

Lead-sulfate Crystals

The absence of lead-sulfate crystals on the positive plate is an indication that the initial charge is completed. After a satisfactory initial charge, no lead-sulfate crystals or gray coloration should be visible on the vertical positive plate columns when examined with a flashlight. Hold the flashlight close to the jar wall at an angle of approximately 45 degrees. The lead-sulfate crystals appear as sparkling diamond-like reflecting particles or as a gray coloration.

The vertical columns should be black or dark brown and totally free of any diamond-like lead-sulfate crystals or gray coloration. The disappearance of lead-sulfate crystals normally occurs in three distinct phases:

- Phase 1: black and crystalline
- Phase 2: gray and lightly crystalline
- Phase 3: black or dark brown and crystal free.

The disappearance of lead-sulfate crystals or gray coloration occurs from top to bottom during initial charge. To insure total absence of lead-sulfate crystals or gray coloration, concentrate inspection for crystals at the bottom of the positive plate vertical columns.

After return to float following the initial charge, cells should be floating in the range of the average applied voltage ± 0.05 volt. 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, continue the battery string on initial charge at 2.5 to 2.55 volts for a total charge time not to exceed 250 hours. If charging fails to clear the lead-sulfate crystals within 250 hours, report the cells to Lineage Power.

From Initial Charge To Service

From initial charge to service, maintain battery plant voltage at 2.17-2.20V/cell. After at least 7 days on float and within a week before service, inspect all cells and record the presence or absence of lead-sulfate crystals. Measure and record the cell voltage. If any cell is heavily crystalline and reads 2.09 volts or less, it may be shorted and should be reported to Lineage Power. If any cell is crystalline and voltage measurement reads greater than 2.09 volts, give that cell an individual boost charge at approximately 2.5 volts until it is clear of the crystals.

Electrolyte Levels

Adjustments

Do not adjust electrolyte levels until the cells have been on continuous float charge for at least two weeks. If levels are low (more than 1/4-inch below the low-level mark) after this time, add nominal specific gravity sulfuric acid which meets the requirements of Federal Specification 0-S-801B. If levels are less than 1/4-inch below the low-level mark, add approved water. If the electrolyte levels are higher than 1/4-inch above the top level line, at normal room temperature, adjust by removing electrolyte. Once the electrolyte has been properly adjusted, make all further adjustments by adding approved water only.

Note: Use only distilled or deionized water for storage battery use to bring electrolyte up to the required level.

Final Connection of Cell Groups

Procedure

DANGER! RISK OF EXPLOSION	
<ul style="list-style-type: none"> • Battery gases are explosive. Do not allow sparks or open flame near batteries. • Do not smoke around batteries. • Never charge batteries without vent funnel in place. • Do not handle, move, or work around batteries during or for 48 hours after charging at a voltage greater than 2.20V/cell. • Handle, move, or store charged cells only with vent funnel (NOT orange shipping plug) in place. • If the orange shipping plug must be reinstalled for transportation, let the battery sit for an additional 24 hours at open circuit after the 48-hour float charge (less than 2.20 volts/cell) before removing the vent funnel and replacing it with the orange shipping plug. • Do not allow gas vents to become clogged or an explosion due to internal pressure may result. • Properly ventilate battery area. • Do not place batteries in a sealed enclosure/room. 	

Final Connection of Cell Groups	
Step	Action
1	If cells were divided into smaller groupings for initial charge, adjust charge voltage to 2.17-2.20V/cell and hold for a minimum of 48 hours.
2	Immediately prior to termination of float charge, record total string voltage and individual cell voltages. If any individual cell voltage exceeds 2.30V, reset proper float voltage and hold an additional 48 hours.
3	Disconnect cell groupings and reconnect into final configuration. Place on continuous float charge at 2.17-2.20V/cell within 72 hours of open circuit.

Installation Records

Storage Battery Report

Use the “Storage Battery Report” located in Section 9 to record all pertinent battery information to be documented during the installation process from unpacking and handling to customer turnover. This form is an important part of the customer’s permanent records.

Battery Maintenance Record

Use the “Battery Maintenance Record” located in Section 9 to record results of maintenance procedures. See Section 7, *Maintenance*.

7 *Operation and Maintenance*

Overview

This section provides the information necessary for the proper operation and maintenance of Round Cell batteries.

Maintenance

Maintenance routines for the Round Cell Battery are significantly simplified in comparison to rectangular cell batteries. 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.

The recommended maintenance procedures and intervals for any of the KS-20472 Round Cells are provided in Tables 7-A through 7-D. The procedures themselves are detailed in the pages that follow the tables.

Replacement Procedures

The following procedures are included in this section:

- Replace a Cell in an Existing String
- Replace or Add a String to an Existing Plant

Gassing Rate

The “Gassing Rate” portion of this section provides general information and guidelines for estimating the hydrogen gassing rate of the Round Cell battery. However, it is beyond the scope of this document to provide the detailed methods or the engineering design required to maintain safe levels of hydrogen in battery areas.

Recommended Procedures and Intervals

Table 7-A: Monthly Maintenance Procedures

Schedule	Non-Telecom Applications	Telecom Applications
Quarterly	<ul style="list-style-type: none"> • Visual check of jars and stand to identify any leak corrosion or crystallization • Visual check of electrolyte levels • Float voltage • Check battery cycle monitor • Reference cell temperature • Check battery connections 	<ul style="list-style-type: none"> • None Required
Annually	<ul style="list-style-type: none"> • Perform all Quarterly Checks and Services • Individual cell voltage • Check cell vents. Inspect, clean or replace safety vent funnel, if required. 	<ul style="list-style-type: none"> • None Required under optimum operating conditions. • Under less than optimum conditions, bi-annual maintenance checks and services are required annually
Bi-Annually	<ul style="list-style-type: none"> • Perform all Quarterly / Annual Checks and Services 	<p>Under optimum operating conditions of 77°F or lower, float voltage of 52.08V per string, and void of external vibration, the following checks and services are required Bi-Annually:</p> <ul style="list-style-type: none"> • Visual check of jars and stand to identify any leak, corrosion, or crystallization • Visual check of electrolyte levels • Individual cell voltage • Float voltage • Reference cell temperature • Check battery connections • Check battery cycle monitor (if applicable) • Check cell vents. Inspect, clean or replace safety vent funnel, if required.
Other	<ul style="list-style-type: none"> • Perform discharge capacity test every 4 to 5 years or as indicated by any abnormality 	<ul style="list-style-type: none"> • Perform discharge capacity test every 4 to 5 years or as indicated by any abnormality

Safety

Read Section 4, *Safety*, before performing the maintenance procedures.

Check and Record Battery Float Voltage

Guidelines

- The float voltage can be read four ways:
 - at the charger
 - at the battery monitor
 - with a volt/ohm meter at the battery disconnect
 - at the battery terminals
- Check meter accuracy and calibration periodically.

Caution

- Use extreme caution when making voltage readings to prevent accidental grounding or shorting of leads during test operations. Connections at the meter should be secure and free of any possibility of touching or becoming grounded.
- Never remove connections at the meter end without first disconnecting the test leads from the battery. Remove test lead connections at the battery immediately after each reading is taken.

Check and Record Individual Cells for Crystals

Guidelines

- 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. Corrective action for crystalline cells is not usually an urgent item since the presence of lead-sulfate crystals usually does not mean that the battery or cell is incapable of providing adequate capacity.
- 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.

An easy way to assess the ability of a crystalline cell to deliver capacity is to make a specific gravity reading. If the specific gravity is within ± 0.01 of the nameplate value, the reduction in cell capacity will be approximately 5 percent. Concern for the ability of a crystalline cell to deliver reasonable capacity should begin when the specific gravity decreases by 0.03 of the nameplate value.

Check and Record Individual Cells for Crystals, continued

If Crystals Appear on All Cells in a String

If lead-sulfate crystals appear on all cells in a string, check the following as possible causes for the abnormal condition:

- **Rectifier voltage:** The appearance of lead-sulfate crystals may indicate a low battery plant float voltage. Check the battery plant float voltage and make appropriate rectifier adjustments.
- **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 two weeks). Check plant records to determine if a discharge has occurred. Another method of determining if a plant discharge has occurred is to measure cell specific gravities. Readings of .03 less than the nameplate values on most cells would be a clear indication that a plant discharge has occurred.
- If the presence of lead-sulfate crystals on all cells in a string is not attributable to a plant discharge or improper rectifier voltage, report the condition to Lineage Power.

If Crystals Appear on One or a Few Cells

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

Crystals on One or a Few Cells	
Step	Action
1	Check to see if a plant discharge has occurred.
2	Measure the cell voltage. If a crystalline cell reads 2.09 volts or less and the crystal deposit is heavy, the cell is shorted and should be reported to Lineage Power.
3	Measure temperatures of cells in each tier of the string to determine the extremes of temperature differences. Temperature differences of 5°F (2.8°C) or more between cells in a string can result in the appearance of lead-sulfate crystals in the warmer cells. Provide appropriate ventilation if temperature differences exceed 5°F (2.8°C).

Check and Record Reference Cell Temperature

Guidelines

The Round Cell, like all lead-acid cells, is affected by the temperature of its electrolyte. Observe the following precautions when working with the Round Cell Battery:

Note

To avoid possible electrolyte contamination, NEVER use mercury thermometers to take cell temperature readings. Use toluene thermometers (KS5499 List 1352, List 1353).

- The Round Cell can tolerate extreme temperatures for short and infrequent periods, but every attempt should be made to maintain the electrolyte temperature from exceeding 110°F (43.3°C). Electrolyte temperatures from 77°F (25°C) down to freezing result in lowered battery capacity. Elevated temperatures result in decreased battery life.
- Temperatures of cells within the same string should be within 5°F (2.8°C) 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.

Temperature Reference Cell

During the installation period, one cell in each tier was selected as the temperature reference cell for that tier. This cell is used for taking the temperature measurement.

Procedure

Measuring Reference Cell Temperature	
Step	Action
1	Insert the thermometer into the reference cell through the vent funnel.
2	Submerge the bulb of the thermometer completely in the electrolyte for at least 2 minutes before taking a reading.
3	Record the reference cell temperature.

Check Electrolyte Levels

Guidelines

Maintain the electrolyte level between the black high- and low-level lines on the battery jar. Electrolyte level checking requirements depend upon local conditions. Historical data on the Round Cell indicates that water may need to be added only once every 10 years.

- Use only distilled water, deionized water, or other water approved for storage battery use, to bring electrolyte up to the required level. When the actual electrolyte temperature is below 50°F (10°C), do not raise the electrolyte level appreciably above the minimum level. This helps to prevent an overflow on charge.
- Acid or electrolyte should not be added to any cell as a substitute for adequate charging. Do not contaminate the electrolyte of Round Cells by using the electrolyte from lead-calcium or lead-antimony cells.
- Use the vent funnel on the cell to fill the cell to the proper level.
- Neutralize electrolyte with soda or lime before disposal to prevent damage. Dispose of electrolyte according to local, state, and federal regulations.

Check Individual Cell Float Voltage

Guidelines

It is extremely important to maintain the battery at the proper float voltage.

Determining Float Voltage

Determine the float voltage as follows:

Battery float voltage = 2.17-2.20 x Number of cells for low specific gravity (1.215)

For example, a 60-cell string of 2.17 V/cell should be floated at:

Battery float voltage = 2.17 x 60 = 130.2 volts

Individual cell voltages should typically be within $\pm 0.05V$ of the average.

Taking Voltage Readings

- To make battery readings, use a DMM (Digital Multimeter) with the accuracy of 0.02 percent on the dc scale.
- Check meter accuracy and calibration periodically.

Caution

- Use extreme caution when making voltage readings to prevent accidental grounding or shorting of leads during test operations. Connections at the meter should be secure and free of any possibility of touching or becoming grounded.
- Never remove connections at the meter end without first disconnecting the test leads from the battery. Remove test lead connections at the battery immediately after each reading is taken.

Check Battery Cycle Monitor

Guidelines

- Record all discharges.
- Record time, date, duration, and end of discharge voltage (UPS applications only).

Inspect Battery Jars and Stands

Cleaning Cell Jars and Covers

Cleaning Cell Jars and Covers	
Step	Action
1	<p>Depending on whether or not spilled electrolyte is on the cells, clean using one of the following methods:</p> <ul style="list-style-type: none"> • If electrolyte has dripped on cells, neutralize the electrolyte by wiping it up with a weak soda solution. • If there is no spilled electrolyte on the cells, but general cleaning is needed, clean with a cloth dampened in clean water.
2	<p>Properly dispose of cleaning cloths.</p> <p>Note: Electrolyte is considered to be Hazardous Waste. After cleaning corroded areas, dispose of cleaning cloths according to local, state, and federal regulations.</p>

Cleaning Battery Stands, Cabinets, and Miscellaneous Equipment

Cleaning Battery Stands, Cabinets, and Miscellaneous Equipment	
Step	Action
1	Wipe battery stands, cabinets, etc., at regular intervals with a cloth dampened in clean water.
2	<p>Clean corrosion on metal battery stands with a metal brush.</p> <p style="text-align: center;">Warning</p> <p>Never bring the wire brush close to cell terminals and intercell connectors.</p>
3	<p>Wipe corroded areas with a cloth dampened with a weak soda solution, then wipe with a cloth dampened in clean water.</p> <p>Note: Electrolyte is considered to be Hazardous Waste. After cleaning corroded areas, dispose of cleaning cloths according to local, state, and federal regulations.</p>

Inspect, Clean, or Replace Safety Vent Funnel

Guidelines

Pressure will build up inside the cell if the vent funnel becomes clogged. The vent funnel is the screw type and can be removed by turning it counterclockwise one-fourth turn.

Procedure

Inspect, Clean, or Replace Safety Vent Funnel	
Step	Action
1	Neutralize vent funnels in a weak soda solution and clean with water and a brush if they become clogged.
2	Replace damaged vent funnels.

Check Battery Connections

Guidelines

- Only re-torque connection if the intercell connection resistance is greater than the values listed below. The intercell connection resistance should be no greater than 5 microohms of the following values:
 - two 12" x 1" x 1/8" connectors 48 microohms
 - four 12" x 1" x 1/8" connectors 31 microohms
 - two 12" x 2-1/2" x 3/8" connectors 19 microohms
- Refer to original readings for inter-tier and inter-row cabling.
- Tolerance is ± 5 microohms
- In the event the connection resistance is greater than the above data, refer to “Intercell Connectors” in the Installation section and the following information.

Safety

- Do not loosen or remove a battery connection while cells are gassing, charging, or discharging. Disconnect string from the load and charger.
- Connect to the battery terminals first before connecting to the load or charging system.
- Only perform this operation after the battery has been on float for at least 48 hours.
- Battery connections should be tight and corrosion-free.
- Be sure that all intercell connections are tight except for the connection that is being opened for cleaning or other purposes.

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 to discharge the static electricity from your body.

Check Battery Connections, continued

Corrosion

Corrosion from electrolyte is usually caused 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.

Opening Battery Connections

Use the following insulated tools for making connections and discharge all static electricity from your body before performing any work on or around the Round Cell batteries:

- Torque wrench capable of measuring 150 inch-pounds
- 1/2-inch box wrench

DANGER

An explosion could occur when sparks are created near the battery string.

Torque connections to 150 inch-pounds maximum.

Caution

Over-tightening of the connections could break lead posts and connector bolts or strip the bolt and/or nut threads, resulting in loose connections.

Check Battery Connections, continued

Cleaning Battery Connections

Cleaning Battery Connections	
Step	Action
1	<p>Clean the corroded post, intercell connectors, and terminal details using a cloth dampened in a strong soda solution, then wipe with a cloth dampened in clean water.</p> <p>Notes:</p> <p>Do not allow neutralizing solutions to enter the cell.</p> <p>Electrolyte is considered to be Hazardous Waste. After cleaning corroded areas, dispose of cleaning cloths according to local, state, and federal regulations.</p>
2	Replace damaged vent funnels.
3	<p>Use a round, soft-bristled, bore brush to clean terminal post bolt holes for intercell connectors.</p> <p style="text-align: center;">DANGER</p> <p>Bore brush rod and handle must be nonconductive. A short circuit across both terminals or to ground can be fatal.</p>
4	<p>Sand to a bright finish the sides of each terminal post to which connections are made.</p> <p>Note: Do not abrade the intercell connectors or the fastening hardware.</p>
5	Wipe the contact areas of intercell connectors and terminal with a clean cloth and coat with NO-OX-ID A [®] special compound.

Perform Discharge Capacity Test

Guidelines

The discharge capacity test is the best way to determine if sufficient reserve power is available. It is not required for routine maintenance, since the capacity of the Round Cell under float conditions increases with age. The discharge capacity test should be run directly off float charge without prior boost charge. Cells to be tested should have been on float for at least 1 month without a boost charge and without a power failure exceeding 30 minutes.

Procedure

Perform the following steps for a complete discharge capacity test:

Discharge Capacity Test	
Step	Action
1	Refer to the tables in Section 8, <i>Discharge and Power Data</i> , and select a discharge rate and end of discharge voltage to be used for the discharge test.
2	Just prior to the discharge capacity test, record the following for the cells to be discharged: <ul style="list-style-type: none"> • Cell float voltage • Electrolyte temperature • Temperature-corrected specific gravity • Presence or absence of lead-sulfate crystals
3	Perform the discharge by applying the load recorded in Step 1 directly from float. It will be necessary, particularly at the beginning of the discharge, to monitor the discharge current and adjust the load bank as necessary to maintain a constant load of the battery as it drops in voltage.
4	Record individual cell voltages and discharge current periodically throughout the test to establish a smooth discharge curve and to verify that the discharge current was properly maintained.
5	Record the time (in minutes) required to discharge the battery to the end of discharge voltage selected in Step 1.
<i>Continued on next page.</i>	

Perform Discharge Capacity Test, continued

Discharge Capacity Test, continued																	
Step	Action																
6	Measure the electrolyte temperature again near the end of the discharge.																
7	<p>Determine the percent of rated capacity for the battery at 77°F (25°C) using the following formula:</p> $\% \text{ Rated Capacity} = ([\text{discharge time (minutes)} / \text{rated discharge time (minutes)}] / 100) \pm K$ <p>Note: K is the correction factor for electrolyte temperature at the beginning of the discharge. Add 0.5% per degree Fahrenheit for temperatures below 77°F/25°C or subtract 0.5% per degree Fahrenheit for temperatures above 77°F/25°C. K may be obtained from Figure 7-1.)</p> <p>Example: Assume electrolyte temperature of 60°F (15.55°C) at start of discharge and 276 minutes to 1.75 volts. From Figure 7-1, K (the correction factor) equals plus 9 at 60°F. Therefore, percent of 5-hour rated capacity is (276/3) + 9 = 101 percent.</p>																
<table border="1"> <caption>Data points for Figure 7-1</caption> <thead> <tr> <th>Electrolyte Temperature (Degrees F)</th> <th>Correction Factor - K</th> </tr> </thead> <tbody> <tr><td>40</td><td>+22.5</td></tr> <tr><td>50</td><td>+15</td></tr> <tr><td>60</td><td>+7.5</td></tr> <tr><td>77</td><td>0</td></tr> <tr><td>90</td><td>-7.5</td></tr> <tr><td>100</td><td>-15</td></tr> <tr><td>110</td><td>-22.5</td></tr> </tbody> </table>		Electrolyte Temperature (Degrees F)	Correction Factor - K	40	+22.5	50	+15	60	+7.5	77	0	90	-7.5	100	-15	110	-22.5
Electrolyte Temperature (Degrees F)	Correction Factor - K																
40	+22.5																
50	+15																
60	+7.5																
77	0																
90	-7.5																
100	-15																
110	-22.5																
Figure 7-1: Correcting Capacity for Temperature																	
8	Recharge cells as soon as possible following a discharge.																

Measure Specific Gravity

Guidelines

Measuring specific gravity as a regular maintenance routine is not required for the Round Cell. Specific gravity readings are recommended only when problems arise. Before measuring the specific gravity of any of the cells, review the safety admonishments and precautions in Section 4, *Safety*.

Note

To avoid electrolyte contamination, hydrometers used in lead-calcium or lead-antimony cells should not be used in the Round Cell.

- The correct specific gravity of the electrolyte used in Round Cell Batteries is 1.215 ± 0.005 . The electrolyte is the same sulfuric acid normally used in lead-acid batteries.
- Take specific gravity readings before rather than after adding water. This is because the water and electrolyte do not mix completely for some time. After water is added, the Round Cells on float charge will regain full charge specific gravity in approximately 10 weeks.
- After a discharge, specific gravity readings continue to read low even after the cells are fully recharged at float charge voltage. Recharge at float voltage does not generate sufficient amounts of gas to mix the electrolyte quickly and, consequently, low specific gravity readings will be obtained temporarily. In approximately 10 weeks, the electrolyte throughout the cell will have mixed sufficiently to give accurate specific gravity readings.
- Electrolyte specific gravity readings vary inversely with temperature. The nominal reading is 1.215 ± 0.005 at 77°F (25°C). Some thermometers have a built-in correction scale to show the equivalent specific gravity reading at each temperature. If no correcting thermometer is available, calculate the correct specific gravity by adding 1 point (0.001) to the hydrometer reading for each 3 degrees Fahrenheit (1.67 degrees Celsius) that the electrolyte is above 77°F (25°C) or by subtracting 1 point (0.001) from the hydrometer reading for each 3 degrees Fahrenheit (1.67 degrees Celsius) that the electrolyte is below 77°F (25°C).

Replace a Cell in an Existing String

Introduction

New Round Cells may be intermixed directly into an existing string of older Round Cells (of the same capacity and acid specific gravity) when necessary for replacement purposes. ***However, never mix different AH-rated Round Cells in the same string.***

Lineage Power recommends disconnecting the existing string from the load and charger before replacing cells. However, if circumstances require that a cell be replaced in an existing string without removing the string from the plant bus, follow guidelines in “String Connected to Load/Charger.”

Replace a Cell in an Existing String, continued

String Disconnected from Load/Charger

- Only qualified, trained personnel that have read and understand the hazards described in the Safety section of this manual should perform this work. Appropriate protective equipment must be used.
- Unpack and prepare new batteries according to the appropriate instructions in the installation section.
- In addition to other safety precautions:
 - Make sure the existing string has been at float (less than 2.20 volts/cell) for at least 48 hours.
 - Isolate the existing string from the charger and load before making/removing any electrical connections at the battery terminals.
 - Make sure the vent funnel has been properly installed on the new cell(s).
- When replacing one or more cells in a battery string, the replacement cell(s) need to be charged according to Table 6-A. The initial charge can be applied in one of two ways:
 - Install replacement cell(s) in the string and then give them an initial charge.

Note: If the initial charge of the new cell(s) is done within the string, the number of cells replaced at the same time within a string should be limited to less than 10% of the number of cells that are in the string.

- Charge the replacement cell(s) separately following the appropriate procedures in the installation section prior to replacement. In this case, following the initial charge, keep the cell(s) on continuous float at 2.17-2.20V/cell until the replacement can be made. The time between discontinuing the float charge at 2.17-2.20V/cell and the completion of replacement should not exceed 24 hours.

Replace a Cell in an Existing String, continued

String Connected to Load/Charger

- Only qualified, trained personnel that have read and understand the hazards described in the Safety section of this manual should perform this work. Appropriate protective equipment must be used.
- Follow the appropriate procedures in the installation section for unpacking and performing the initial charge on the cell(s).
- In addition to other important safety precautions, ensure the following:
 - The vent funnel has been properly installed before making any electrical connections to the new battery.
 - The string and new cell has been at float (less than 2.20 volts/cell) for at least 48 hours.
 - The time the new cell is left on open circuit after charging and before connecting into the new string does not exceed 24 hours.
- One cell at a time may be replaced in an existing string without removing the battery string from the plant bus.

Warning

This process increases the risk of creating sparks at the battery terminals and should be avoided unless absolutely necessary. It is extremely important that this process only be performed by qualified, trained personnel who have read and understand the hazards described in the safety section of this product manual and who are using the proper protective equipment.

Replace a Cell in an Existing String, continued

String Connected to Load/Charger, continued

Connect the new cell in parallel with the defective (old) cell using two pairs of suitable length cables (see Figure 7-2).

DANGER RISK OF EXPLOSION

The string and new battery must be verified to have been on float charge at a voltage less than 2.20 volts/cell for at least 48 hours before performing this function.

WARNING ELECTRICAL HAZARD

Insulate the end of the cable that is not connected if the other end is connection to the battery terminal.

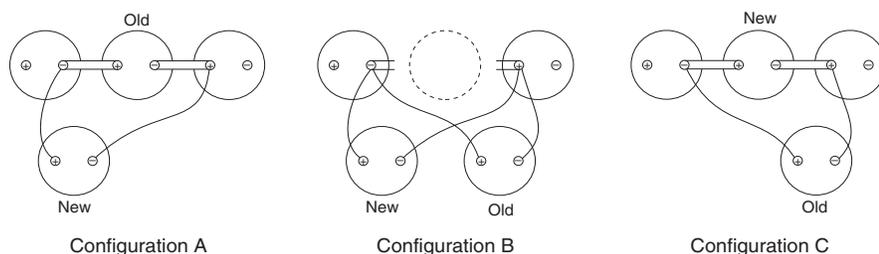


Figure 7-2: Replacing a Defective Cell With a New Cell

Replace or Add a String to an Existing Plant

Introduction

Only qualified, trained personnel that have read and understand the hazards described in the Safety section of this manual should perform this work. Appropriate protective equipment must be used.

Follow the appropriate procedures in the installation section for unpacking and preparing the batteries.

Guidelines

Follow these guidelines for replacing or adding a string to an existing plant:

- Strings of Round Cells can be used in parallel with strings of rectangular cells, providing the electrolyte specific gravities are the same. *Never mix Round Cells in the same string with rectangular cells.*
- When adding a new string in parallel to an existing string:
 - Apply the initial charge to the new string only. After the initial charge is completed, reduce the charging rectifier's voltage to the float voltage. Leave the new string on this rectifier for 48 hours before it is transferred over to the working plant.
 - When connecting a string in parallel with another string, see that both strings are approximately the same potential (less than 0.05 volt difference) to prevent arcing.

Gassing Rate

Overview

All lead-acid batteries generate hydrogen and oxygen gas at the negative and positive plates respectively. The generation of these gases occurs during all conditions of use, including charge, discharge and while on open circuit during storage. The rate of gas generation on discharge and open circuit is generally very small but cannot be completely ignored. For this reason, never place lead-acid batteries in an airtight enclosure. Explosive mixtures of hydrogen in air are present when the hydrogen concentration exceeds four (4) percent by volume. The concentration of oxygen does not significantly change the lower explosive limit of hydrogen in air, and therefore, only hydrogen will be considered here.

If the concentration of hydrogen in air exceeds four (4) percent by volume, there is a risk of explosion if the gas is ignited. Therefore, to provide a margin of safety, lead-acid battery areas must be ventilated to limit the accumulation of hydrogen gas under all anticipated use conditions to a recommended maximum of two (2) percent of the total free volume in the battery area.

In flooded lead-acid batteries, the gassing rate approaches the theoretical value calculated from the dissociation of water. From electrochemical theory, if all the charging current is used to generate gas, **each cell will generate 0.016 cubic feet of hydrogen per hour, per ampere of charging current at 77°F (25°C) and one atmosphere pressure.**

For example, a 48V string of lead-acid batteries requiring 0.1 Amp of float current at 77°F can produce as much as 0.04 cubic feet of hydrogen per hour ($0.016\text{ft}^3/\text{hr} \times 0.1 \text{ Amp} \times 24 \text{ cells}$).

The quantity of fresh air required to maintain an explosion safe environment in the battery area will vary greatly depending on many factors including, but not limited to, the age and condition of the battery, the number of cells in the battery area, the battery temperature and the current flowing through the batteries. Therefore, the design of a ventilation system for batteries in a specific application requires careful consideration of factors other than the gassing rate of new batteries in typical float operation. Typical gassing rates may be useful as a “best case” condition, but cannot adequately address “worst case” or any other operating condition that may occur during the service life of the battery.

8 *Discharge and Power Data*

Overview

In This Section

The tables in this section present detailed summaries of discharge capacities for each Round Cell model.

Note

Round Cells are capacity tested before shipment and after 6 days float. The data provided in these tables represent the guaranteed minimum value at the time of shipment and are the minimum values for the lifetime of the cells.
--

Battery Discharge Capacity Tables

Tables 8-A through 8-H provide battery discharge capacity information for the Round Cell when used in standby reserve applications.

Table 8-I provides one- and five-minute rate performance to 1.75 V/cell for all Round Cells.

**Table 8-A: Ratings Table for List 1S Round Cell Batteries
(Discharge Currents are in Amperes)**

Hours Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.75 V	1.80 V	1.84 V	1.86 V	1.88 V	1.90 V
1.0	650	600	545	485	440	400
1.5	545	500	450	400	383	343
2.0	460	440	400	373	341	311
2.5	400	387	354	329	306	286
3.0	360	347	319	301	280	259
3.5	333	313	291	277	260	241
4.0	304	287	268	256	242	226
4.5	281	266	250	240	227	212
5.0	260	247	235	226	213	198
5.5	244	233	222	214	203	189
6.0	231	220	210	204	193	180
7.0	206	198	191	186	177	167
8.0	188	181	176	172	163	154
9.0	173	166	164	160	152	143
10.0	161	154	153	151	143	135

Note: The values in this table include intercell connector loss. This loss is based on the use of four 12" x 1" x 1/8" lead-plated copper straps with an average intercell resistance of 31 microohms.

*Hours reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-B: Battery Discharge Amperes Model KS-20472,
List 2S Cells**

Hours Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.75 V	1.80 V	1.84 V	1.86 V	1.88 V	1.90 V
1.0	360	310	265	245	225	220
1.5	285	255	230	215	190	170
2.0	245	218	195	182	180	160
2.5	218	205	187	175	163	150
3.0	192	181	167	158	148	136
3.5	172	164	152	145	135	125
4.0	161	148	139	133	125	116
4.5	144	138	130	124	116	109
5.0	133	128	122	116	110	103
5.5	125	120	114	109	103	96
6.0	118	113	107	103	98	93
7.0	106	100	97	94	89	84
8.0	97	91	88	85	81	78
9.0	89	84	80	79	75	72
10.0	82	78	75	73	71	67

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 1" x 1/8" lead-plated copper straps with an average intercell resistance of 48 microohms.

*Hours reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-C: Battery Discharge Amperes Model KS-20472,
List 3S Cells**

Hours Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.75 V	1.80 V	1.84 V	1.86 V	1.88 V	1.90 V
1.0	200	172	147	136	130	125
1.5	158	142	130	120	115	110
2.0	136	120	110	108	107	100
2.5	115	111	106	101	97	91
3.0	105	102	96	92	88	83
3.5	97	93	88	85	80	75
4.0	90	86	81	78	74	70
4.5	83	79	75	73	69	65
5.0	77	74	70	67	65	61
5.5	72	70	66	63	60	57
6.0	67	66	61	59	57	54
7.0	60	58	56	54	51	48
8.0	55	53	51	49	48	46
9.0	49	49	47	46	44	42
10.0	47	45	43	42	41	40

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 1" x 1/8" lead-plated copper straps with an average intercell resistance of 48 microohms.

*Hours reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-D: Battery Discharge Amperes Model KS-20472,
List 4S Cells**

Hours Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.75 V	1.80 V	1.84 V	1.86 V	1.88 V	1.90 V
1.0	120A	104	88	82	75	75
1.5	95	85	78	75	72	65
2.0	82	72	66	65	70	60
2.5	73	71	68	64	61	57
3.0	65	63	60	57	54	50
3.5	58	57	54	52	49	46
4.0	54	52	49	47	45	42
4.5	49	47	47	45	42	39
5.0	46	45	44	42	39	38
5.5	43	42	41	39	37	36
6.0	41	39	38	37	36	34
7.0	37	36	35	34	33	31
8.0	33	33	32	31	30	29
9.0	31	30	29	28	27	27
10.0	29	28	27	27	26	25

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 1" x 1/8" lead-plated copper straps with an average intercell resistance of 48 microohms.

*Hours reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-E: Battery Discharge Amperes High Rate, UPS Rate
Model KS-20472, List 1S Cells**

Minutes Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.55 V	1.60 V	1.65 V	1.70 V	1.75 V	1.80 V
5	2050	1880	1595	1445	1200	1050
10	1730	1685	1570	1330	1150	950
15	1600	1490	1360	1225	1080	920
20	1415	1350	1255	1140	1025	870
25	1270	1225	1160	1075	970	840
30	1160	1120	1090	1005	900	790

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 2-1/2" x 3/8" lead-plated copper straps with an average intercell resistance of 19 microohms.

*Minutes reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-F: Battery Discharge Amperes High Rate, UPS Rate
Model KS-20472, List 2S Cells**

Minutes Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.55 V	1.60 V	1.65 V	1.70 V	1.75 V	1.80 V
5	1160	1105	1040	965	800	645
10	1050	1000	920	835	735	595
15	925	875	820	750	660	560
20	795	755	715	655	585	490
25	670	655	630	595	545	430
30	575	570	565	540	470	385

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 2-1/2" x 3/8" lead-plated copper straps with an average intercell resistance of 19 microohms.

*Minutes reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-G: Battery Discharge Amperes High Rate, UPS Rate
Model KS-20472, List 3S Cells**

Minutes Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.55 V	1.60 V	1.65 V	1.70 V	1.75 V	1.80 V
5	775	750	710	655	500	430
10	675	635	605	535	460	390
15	540	520	500	450	410	360
20	470	455	440	400	360	320
25	390	380	365	340	315	295
30	320	315	310	305	290	280

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 2-1/2" x 3/8" lead-plated copper straps with an average intercell resistance of 19 microohms.

*Minutes reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-H: Battery Discharge Amperes High Rate, UPS Rate
Model KS-20472, List 4S Cells**

Minutes Reserve At 77°F*	End Of Discharge Volts Per Cell					
	1.55 V	1.60 V	1.65 V	1.70 V	1.75 V	1.80 V
5	500	485	460	430	350	270
10	440	410	390	335	320	245
15	350	330	320	315	270	235
20	310	300	285	255	235	205
25	245	235	225	220	215	170
30	235	225	220	215	180	150

Note: The values in this table include intercell connector loss. This loss is based on the use of two 12" x 2-1/2" x 3/8" lead-plated copper straps with an average intercell resistance of 19 microohms.

*Minutes reserve reflect cell performance at electrolyte specific gravity of 1.215 ±0.005 at 77°F.

**Table 8-I: Estimated 1 and 5 Minute Rate in Amperes
to 1.75 Volts Per Cell**

Model	1 Minute/5 Minute
List 1S	1200
List 2S	800
List 3S	500
List 4S	350

Notes:

The values in this table include intercell connector loss. This loss is based on the use of two 12" x 2-1/2" x 3/8" lead-plated copper straps with an average intercell resistance of 19 microohms.

For any given model, the one and five minute rates are the same because of restrictions imposed by the coup-de-fouet in the discharge curve.

9 *Installation and Maintenance Records*

Overview

Introduction

The forms in this section should be reproduced and used to keep records for batteries.

Note

Failure to adhere to the maintenance schedules and routines described in the <i>Maintenance</i> section of this product manual will void the product warranty and may result in reduced performance of your batteries.
--

Storage Battery Report

The battery installer should follow the instructions in Section 6, “Unpacking and Handling” and “Installation Records,” to begin the recordkeeping on the “Storage Battery Report.” **The installer should then turn these records over to the Maintenance organization, who keeps them as part of their permanent records.**

Battery Maintenance Record

The Maintenance organization will record results of maintenance procedures on the “Battery Maintenance Record.” If a warranty claim is made, the Maintenance organization will be required to show records to support the claim.

Refer to Section 7, *Maintenance*, for required actions and measurements.

Lineage Power - STORAGE BATTERY REPORT

TOWN AND STATE		OFFICE		JOB ORDER NO.		KS		PILOT CELL NO. (NOTE 5)		DATE CELLS SHIPPED		NO. OF STRINGS CHARGED IN PARALLEL		SHEET ___ OF ___ SHEETS									
STREET ADDRESS				SUPPLIER ORDER NO.				TELEPHONE COMPANY				CONNECTED TO WORKING EQUIP YES ___ NO ___				DATE CHARGE STARTED				BATTERY DESIG.			
INDIVIDUAL MEASUREMENTS																							
CELL NO.	ELEC. LEVEL (NOTES 1 & 2)		48 HRS AFTER END OF INITIAL CHARGE				FLOAT AT TURNOVER				INITIAL CHARGE (NOTE 7)				MEASUREMENTS START OF INITIAL CHARGE TO TURNOVER								
	AS REC.	CORR. - 1/4 Inch - Pints	DATE	VOLTS IN EXCESS OF 2.00	CRYSTALS (NOTE 3)	TEMP DEG. F	GRAVITY IN EXCESS OF 1,000	MEAS. CORR.	VOLTS IN EXCESS OF 2.00	CRYSTALS (NOTE 3)	TEMP DEG. F	DATE	AVG. VOLTS (NOTE 4)	TEMP DEG. F	MONTH	DAY	HOUR	GRAVITY IN EXCESS OF 1,000	MEAS. CORR.	TEMP DEG. F	BATTERY STRING VOLTAGE		
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
0																							
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
0																							
1																							
2																							
3																							
4																							
TOTAL HOURS OF CHARGE:												REMARKS											
MEASUREMENTS BY: _____ DATE OF TURNOVER: _____ APPROVED BY: _____ DATE: _____																							

Front

Battery Maintenance Record

For Year _____

Office ID	City and State
Supervisor's Name	Phone

Type of Power Plant	Total Rectifier Capacity (Amps)
Battery type = KS-20472 List#	Typical Plant Load (Amps)

Monthly: Check and Record Battery Float Voltage

Month	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
Volts												
Tech Init.												

Quarterly: Check and Record Individual Cells for Crystals; Check and Record Reference Cell Temperature; Check Electrolyte Levels.

	(Circle)	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
String A	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
String B	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
String C	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
String D	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
String E	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
String F	Cell #'s w/crystals												
	Temperature Reference Cell												
	Water Added to Cell #'s or OK												
	Recorded by:												

Battery Maintenance Record

(Use Additional Sheets if Required)

Date: _____ Recorded by: _____

Annually: Check and Record Individual Cell Float Voltages; Check Battery Cycle Monitor (if applicable);
Inspect Battery Jars and Stands; Inspect Safety Vent Funnel

Cell #	String A		String B		String C		String D		String E		String F	
	Volts	T Ref Cell										
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												

Battery Cycle Monitor Reading: _____ (if applicable)

Power Outage Log:

Date	Time	Duration	Remarks	Initials

10

Material Safety Data Sheet

This section contains the Material Safety Data Sheet for the Round Cell Batteries.

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MATERIAL SAFETY DATA SHEET

Tyco Electronics
3000 Skyline Drive
Mesquite, TX 75149

Issue Date: 01/28/98
Issue Number: 6
Supersedes Date: 05/27/97

Non-Emergency Telephone # 1-800-THE-1PWR (1-800-843-1797)

Emergency Telephone # 800-424-9300 (CHEMTREC)

Use CHEMTREC only in the event of chemical emergencies involving a spill, leak, fire, exposure, or accident involving chemicals.

Reason for Re-Issue: Reformat

I. PRODUCT IDENTIFICATION

Product Name: Battery, Round Cell KS-20472

Chemical Name/Synonym: KS-20472, Flooded Lead-acid Battery

Product Code/Comcode: 402785232, 402785240, 402785257, 402785265

HMDB Number: 9928

Label Codes

Health: 3 - Corrosive
Fire: 0 - Non-flammable
Reactivity: 2 - Moderately reactive

II. HAZARDOUS INGREDIENTS

<u>Component</u>	<u>CAS #</u>	<u>%</u>	<u>TLV(ACGIH)</u>	<u>PEL(OSHA)</u>
*Lead and lead sulfate (7446-14-2)	7439-92-1	< 60	50 ug/m ³	50 ug/m ³
**Sulfuric acid	7664-93-9	10-30	1 mg/m ^{3,1}	1 mg/m ¹

¹STEL (ACGIH): 3 mg/m³

¹STEL (OSHA): N/A

Comments: The data presented refer primarily to the acid electrolyte since this compound poses the predominant immediate hazard associated with this product. *These chemicals are subject to Section 313 Title III SARA Reporting Requirements. **This chemical in its existing form is not subject to SARA 313 Title III Reportable Requirement. However, if the use of this product results in aerosol formation of this chemical, then the aerosol of this chemical is subject to SARA 313 Title III Reportable Requirements.

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III. PHYSICAL PROPERTIES

Appearance/Odor: Acid electrolyte is clear with a strong acrid odor.
Specific Gravity: 1.30
Boiling Point: > 219 °F
Vapor-Pressure: > 20 mm Hg at 77 °F
Evaporation Rate: < 1
% Volatiles by Volume: N/A
% Volatile Organic Carbon: N/A

Vapor Density (Air=1): 3.4
Melting Point: -17 °F
Solubility in Water: Soluble
pH: < 1

IV. HEALTH HAZARD SUMMARY

Primary Routes of Exposure

Oral: **Skin:** X **Eye:** X **Inhalation:** X

Effects of Overexposure:

The electrolyte is corrosive to skin, eyes, and mucous membranes. Repeated or prolonged inhalation of mists can cause inflammation of the upper respiratory tract and chronic bronchitis; pulmonary edema and death may occur from severe exposures.

Early symptoms of lead intoxication include a persistent metallic taste, vomiting, diarrhea or constipation, and severe abdominal pain. Continued exposures may result in muscle weakness and fatigue, nerve system damage, paralysis, liver and kidney damage, anemia, anorexia, and adverse reproductive and developmental effects.

Listed as a Carcinogen or Potential Carcinogen By the Following Agencies?

NTP: No **IARC:** Yes **OSHA:** No

Toxicity Study Information:

Only select Registry of Toxic Effects of Chemical Substances (RTECS) data are presented here. Consult latest issue for more information.

Sulfuric acid: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mist containing sulfuric acid" as a Category I carcinogen, a substance that is carcinogenic to humans. This classification does not apply to liquid forms of sulfuric acid contained within a battery. The inorganic acid mist is not generated under normal use of this product. Misuse of the product such as overcharging, may result in the generation of sulfuric acid mist.

Lead-TC_{LO}: 10 ug/m³, human, inhalation; **TD_{LO}:** 450 mg/kg/yr, human, oral. Reported to cause chromosomal aberrations in human and animal cells. Causes reproductive and developmental effects in experimental animals.

According to the International Agency for Research on Cancer (IARC) Monograph Supplement (1987), there is inadequate evidence for the carcinogenicity of lead in humans. Lead and inorganic lead compounds are classified as group 2B carcinogens by IARC. OSHA regulated (29 CFR 1910.1025).

Lead sulfate-LD_{LO}: 2 g/kg, dog, oral; **LD_{LO}:** 30 g/kg, guinea pig, oral. Positive sister chromatid exchange assays in human and animal cells.

The lead and lead sulfate contained in this product pose a minimal hazard because they are enclosed. A lead hazard may result during recycling or if battery is discarded improperly.

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V. FIRST AID PROCEDURES

Eye: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention immediately.

Skin: In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion: If swallowed, do NOT induce vomiting. Give victim a glass of water. Call a physician immediately. Never give anything by mouth to an unconscious person.

Notes to physician: None

VI. FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A

Autoignition Temp: N/A

Flammable Limits: LEL: N/A

UEL: N/A

Extinguishing Media: For small fires use carbon dioxide, dry chemical. For large fires, flood area with large quantities of water, while suppressing vapors with waterfog/spray.

Special Firefighting Procedures: Cool battery exterior with water to prevent rupture. Firefighters should wear positive pressure self-contained breathing apparatus and thermal protective clothing to avoid toxic and corrosive mists, vapors, and possibly lead fumes.

Unusual Fire and Explosion Hazards: Sulfuric acid, especially when diluted with water, can react with metals to produce flammable gas. Remove all sources of ignition and ventilate area if battery is ruptured or recharging.

VII. REACTIVITY DATA

Stability: Stable

Conditions to Avoid: Prolonged overcharging; sources of ignition. Do not allow metallic articles to simultaneously contact the negative and positive terminals of the battery.

Incompatibility (Materials to Avoid): Combustibles, organic materials, strong oxidizers and reducing agents, strong acids and bases, active metals, water. Carbides, chlorates, nitrates, picrates, fulminates, halides, halogenates, peroxides, sulfides, potassium, sulfur, nascent hydrogen.

Hazardous Decomposition Products:

Sulfuric acid: Sulfur oxides, sulfuric acid mist, hydrogen.

Lead: Presence of nascent hydrogen may generate toxic arsine gas.

Thermal decomposition of battery casing may produce nitrogen oxides and cyanides.

Hazardous Polymerization: Will not occur

Conditions to Avoid: None

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VIII. SPECIAL PROTECTION INFORMATION

Ventilation: General ventilation should be adequate under normal conditions of use.
Respiratory Protection: Respirators are not required under normal conditions of use. Use NIOSH approved respirator for acid mist if PEL or TLV is exceeded when handling electrolyte.
Protective Gloves: Required. Neoprene, rubber, or polyethylene types are suggested.
Eye Protection: Required. Chemical splash goggles or full face shield is suggested.
Other Clothing and/or Equipment: Eyewash and safety shower should be available for immediate use. Rubber boots and rubber apron in accordance with potential for electrolyte exposure. Long legged and long sleeved clothing.

IX. ENVIRONMENTAL INFORMATION

Steps to be Taken in Case Material is Released or Spilled: If an acid spill is external to the battery, cover the spill with clay or other recognized acid absorbing agent. Neutralize the acid with sodium bicarbonate (baking soda) or other recognized neutralizer. In an emergency sand, ashes, or gravel can be used to cover spill, and soda ash or lime used to neutralize acid; such substances should not be used on the battery itself as they can cause damage to it. Do not flush with water, even after acid has been neutralized.
Waste Disposal Method: Contains lead. Dispose of according to all applicable regulations.
TSCA Status: All components appear on the TSCA chemical substance inventory.
Shipping Information: USDOT/IATA: Name: Battery, Wet, Filled with acid
Class: 8 ID#: UN2794 PG: III

X. SPECIAL PRECAUTIONS

Storage and Handling Requirements:

Store in a cool, dry, well ventilated area. Protect batteries from physical damage. All lead acid cells have enormous circuit capability. Extreme care should be exercised to avoid shorting of cell terminals. When working around cells remove rings, wrist watches, necklaces, metal bracelets, belt buckles, etc. Explosive hydrogen gas may be generated during charging. Avoid creating sparks, keep away from sources of ignition and ventilate area during charging.

N.D. = Not Determined

N/A = Not Applicable.

While information in this fact sheet has been compiled from reference materials and other sources believed to be reliable, its accuracy and completeness is not guaranteed, nor is any responsibility assumed or implied for any loss or damage resulting from inaccuracies or omissions. Any specific evaluation will involve professional judgement by the user's industrial hygiene personnel.

11 *Product Warranty*

Round Cell Battery Warranty:

- A. Seller warrants to Customer that:
 - 1. As of the date title to product sold (Product) passes, Seller will have the right to sell, transfer, and assign such Product, and the title conveyed by Seller shall be good;
 - 2. Upon shipment, Product will be free from defects in material and workmanship, and will conform to Seller's specification.
- B. The Warranty Periods and Conditions applicable to new products are listed below:

Table 11-A: New Battery Warranty Periods and Conditions

Warranted Life	Maximum Battery Temperature (see Note)	Full Replacement	Pro-Rata Replacement
40 years	77°F (25°C)	15 years	25 years
20 years	90°F (32°C)	8 years	12 years
10 years	100°F (38°C)	4 years	6 years
5 years	110°F (43°C)	2 years	3 years
1 year	122°F (50°C)	6 months	6 months
No Warranty	>122°F (>50°C)	0	0

Note: Operation or storage of batteries for any length of time above 122°F (50°C) will void the product warranty.

Temperature and maintenance records shall be maintained by Customer in accordance with Seller's published instructions in the *Operation and Maintenance* section of this product manual.

Cycles and discharge depth shall not exceed:

- 100 Cycles during warranted years of life with a 30 percent discharge depth
- 75 Cycles during warranted years of life with a 50 percent discharge depth
- 50 Cycles during warranted years of life with a 100 percent discharge depth

The Warranty Period commences on the date of manufacture.

If, during the Warranty Period, a defect or nonconformity is identified in a Product and Customer notifies Seller in writing of such defects or nonconformity, and follows Seller's instructions regarding return of defective or nonconforming Products, Seller shall, at its option, repair or replace such Product without charge or provide a credit as specified in Paragraph C. Where Seller has elected to repair a Product and Seller ascertains that the Product is not readily returnable for repair, Seller will repair the Product at Customer's site.

C. If notification of defect is:

- Within the years of the full replacement portion of the Warranty, Seller will, at its option, either repair or replace the Product or provide a 100 percent credit based on the lesser of either current price or original purchase price. Credit will be applied to a replacement Lineage Power product.
- Within the years of the pro-rata replacement portion of the Warranty, Seller will, at its option, either repair or replace the Product or provide a credit based on the following pro-rata formula: $C = [(WR - ML)/WR] \times PR$

where: C = Credit
ML = Months of Life Obtained
PR = Current Replacement Billing Price

WR = Warranted Months of Life as
determined in Paragraph B.

Credit will be applied to a replacement Lineage Power product.

- D. During the Full Warranty Period, Seller will bear the cost of removal of defective or nonconforming Product and reinstallation of replacement Product. Beyond the Full Warranty Period, cost of removal and the reinstallation shall be borne by Customer. Products returned for repair or replacement will be accepted by Seller only in accordance with its instructions for such returns. The transportation expense and risk of loss associated with returning such Product to Seller shall be borne by Customer. Seller shall bear the cost of transportation and risk of loss of the repaired or replacing Product to the destination originally designated by Customer at time of purchase. When Seller has elected to replace Product or give credit, Product shall remain the Buyer's property to be disposed of in accordance with Federal, State, and local regulations for hazardous materials.
- E. If Seller determines that a Product for which warranty service is claimed is not defective or nonconforming, Customer shall pay or reimburse Seller for all costs of handling, inspecting, testing, disposal, and transportation, and, if applicable, traveling and related expenses.
- F. Seller makes no warranty with respect to defective conditions or nonconformities resulting from actions of anyone other than Seller or its subcontractor, caused by any of the following: modifications, misuse, neglect, accident, or abuse; improper wiring, repairing, alteration, installation, storage, or maintenance; use in a manner not in accordance with Seller's specifications, or operating instructions, or failure of Customer to apply previously applicable Seller modifications and corrections. In addition, Seller makes no warranty with respect to Products which have had their serial numbers or month and year of manufacture removed or altered.
- G. A cycle life counter must be installed for each UPS application. Warranty is void if a UPS application is installed without a cycle life counter.
- H. All maintenance records shall be provided for warranty consideration.

- I. Warranty for products that are not recharged within the specified recharge date will be void.
- J. This warranty shall run only to Customer who is a direct purchaser from the Seller.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S SOLE AND EXCLUSIVE REMEDY SHALL BE SELLER'S OBLIGATION TO REPAIR, REPLACE, OR CREDIT AS SET FORTH PREVIOUSLY IN THIS WARRANTY.

Revision History

Issue 8	Rebranding.
Issue 7	Formatting issues.
Issue 6	Page 7-2: Replaced maintenance tables. Page 11-3: Updated warranty statement D.
