

PowerSafe

data safe

Safety, Storage, Installation,
Operation & Maintenance Manual

Flooded Lead-Acid Batteries
C, D, E, F and G



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This manual provides instructions regarding safety, storage, installation, operation and maintenance. Failure to observe the precautions as presented may result in injury or loss of life.

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GENERAL SAFETY INSTRUCTIONS

Warnings in this manual appear in any of three ways:



Danger

The danger symbol is a lightning bolt mark enclosed in a triangle. The danger symbol is used to indicate imminently hazardous situations, locations and conditions which, if not avoided, WILL result in death, serious injury and/or severe property damage.



Warning

The warning symbol is an exclamation mark in a triangle. The warning symbol is used to indicate potentially hazardous situations and conditions which, if not avoided COULD result in serious injury or death. Severe property damage COULD also occur.



Caution

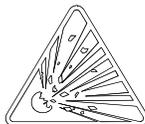
The caution symbol is an exclamation mark enclosed in a triangle. The caution symbol is used to indicate potentially hazardous situations and conditions which, if not avoided may result in injury. Equipment damage may also occur.

Other warning symbols may appear along with the *Danger* and *Caution* symbols and are used to specify special hazards. These warnings describe particular areas where special care and/or procedures are required in order to prevent serious injury and possible death:



Electrical warnings

The electrical warning symbol is a lightning bolt mark enclosed in a triangle. The electrical warning symbol is used to indicate high voltage locations and conditions that may cause serious injury or death if the proper precautions are not observed.



Explosion warnings

The explosion warning symbol is an explosion mark enclosed in a triangle. The explosion warning symbol is used to indicate locations and conditions where molten, exploding parts may cause serious injury or death if the proper precautions are not observed.

IMPORTANT SAFETY INSTRUCTIONS



DANGER

A battery can present a risk of electrical shock and high short circuit current.

The following precautions should be observed when working with batteries.

1. Verify that the Uninterruptible Power Supply (UPS) is off and that the power cord is disconnected from the power source.
2. Remove watches, rings or other metal objects.
3. Use tools with insulated handles to prevent inadvertent shorts.
4. Wear rubber gloves and boots.
5. Do not lay tools or metal parts on top of batteries.
6. Determine if the battery is inadvertently grounded. If inadvertently grounded, remove source of ground. Contact with any part of a grounded battery can result in electrical shock. The likelihood of such shock will be reduced if such grounds are removed during installation and maintenance.
7. Verify circuit polarities before making connections.
8. Disconnect charging source and load before connecting or disconnecting terminals
9. Flooded lead-acid batteries contain an explosive mixture of hydrogen gas. Do not smoke, cause a flame or spark in the immediate area of the batteries. This includes static electricity from the body.
10. Use proper lifting means when moving batteries and wear all appropriate safety clothing and equipment.
11. Do not dispose of lead acid batteries except through channels in accordance with local, state and federal regulations.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for Flooded Lead-Acid Battery Systems that should be followed during the installation and maintenance of the battery system.

Only a qualified EnerSys sales/service representative who is knowledgeable in batteries and the required precautions should perform servicing of the batteries. Keep unauthorized personnel away from batteries.



Caution

Misuse of this equipment could result in human injury and equipment damage. In no event will EnerSys be responsible or liable for either indirect or consequential damage or injury that may result from the use of this equipment.



Caution

Do not dispose of the batteries in a fire. The batteries may explode.



Caution

Do not open or mutilate the batteries. Released electrolyte is harmful to the eyes and skin and may also be toxic.



Warning

Lack of preventative maintenance could result in batteries exploding and emitting gasses and/or flame. An authorized, trained technician must perform annual preventative maintenance.



Warning

Failure to replace a battery before it becomes exhausted may cause the case to crack, possibly releasing electrolytes from inside the battery and resulting in secondary faults such as odor, smoke and fire.



Warning

Installation and servicing of batteries should be performed by personnel knowledgeable about batteries and the required precautions. Keep unauthorized personnel away from the batteries.



Warning

Proper maintenance to the battery system must be done by a qualified service technician. This is essential to the safety and reliability of your Uninterruptible Power Supply (UPS) system.

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1.0 GENERAL INFORMATION

1.1 Introduction

EnerSys flooded lead-acid batteries set the benchmark for reliability and durability in flooded lead-acid batteries and battery systems.

1.2 Precautions

BEFORE UNPACKING, STORING, HANDLING, INSTALLING, OPERATING OR PERFORMING MAINTENANCE ON THE FLOODED LEAD-ACID STATIONARY BATTERY SYSTEM

READ THE FOLLOWING INFORMATION THOROUGHLY!

It is important to read, understand and strictly follow the instructions in this manual.

If the following precautions are not fully understood, or if local conditions are not covered, contact your nearest EnerSys sales/service representative for clarification, or call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems and Services.

Also, refer to all applicable federal, state and local regulations and industry standards.

YOU SHOULD BE TRAINED IN HANDLING, INSTALLING, OPERATING AND MAINTAINING BATTERIES BEFORE YOU WORK ON ANY BATTERY SYSTEM.

1.3 Service

Should you require installation supervision, service, parts, accessories or maintenance, EnerSys has a nationwide service organization to assist with your new battery purchase.

Please call your nearest EnerSys sales/service representative for more information, or, call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems and Services.



2.0 SAFETY

2.1 General

Like all other flooded, lead-acid batteries, batteries may leak, release hydrogen gas or cause acid misting. Always follow the generally accepted safety procedures for handling batteries. In addition, it is vitally important that you observe the precautions recommended in this manual.

YOU SHOULD BE **TRAINED** IN HANDLING, INSTALLING, OPERATING AND MAINTAINING BATTERIES BEFORE YOU WORK ON ANY BATTERY SYSTEM.

You **MUST** understand the risk of working with batteries and **BE PREPARED** and **EQUIPPED** to take the necessary safety precautions. If not, contact EnerSys Integrated Systems and Services.

2.2 Safety Equipment and Clothing

When working with any battery system, be sure you have the necessary tools and safety equipment, including but not limited to:

- insulated tools
- rubber apron
- face protection / face shield
- rubber gloves
- safety goggles
- emergency eye wash and shower, if available
- fire extinguisher
- acid spill cleanup kit

ALWAYS:

- remove all jewelry (i.e., rings, watches, chains, etc.)
- keep sparks, flames and smoking materials away from the battery

NEVER lay tools or other metallic objects on the battery/cell.

Using the correct tools and wearing proper safety equipment will help prevent injury should an accident occur.

2.3 Safety Precautions



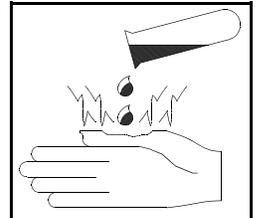
2.3.1 Sulfuric Acid Burns

Batteries are safe when operated and handled properly. However, they do contain sulfuric acid, which can cause burns and other serious injuries.

Always wear protective clothing AND use the correct safety tools.

In case of **SKIN CONTACT** with sulfuric acid, **IMMEDIATELY**

1. **REMOVE** contaminated **CLOTHING**
2. **FLUSH** the area **THOROUGHLY** with **WATER**
3. Get **MEDICAL ATTENTION**, if required.



In case of **EYE CONTACT** with sulfuric acid, **IMMEDIATELY**

1. **FLUSH THOROUGHLY** for at least 15 minutes with large amounts of **WATER**.
2. Get **MEDICAL ATTENTION**.



In case of sulfuric acid **CONTACT WITH CLOTHING OR MATERIAL**, **IMMEDIATELY**

1. **REMOVE** CONTAMINATED CLOTHING
2. Apply a solution of sodium bicarbonate solution (1.0 lb/1.0 gal or 0.5 kg/5.0 liters of water) on the clothing or material.
3. Apply the solution until bubbling stops, then rinse with clean water.

NOTE: In case of a sulfuric acid **SPILL**, bicarbonate of soda or an emergency spill kit should be within the battery room in accordance with OSHA regulations 1910.178g2.

2.3.2 Explosive Gases

Batteries can generate gases which, when released, can explode, causing blindness and other serious personal injury.

Always wear protective clothing and use the correct safety tools.

Eliminate any potential of sparks, flames or arcing.

Provide adequate ventilation. See Appendix.

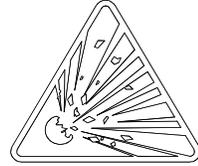
IN CASE OF FIRE: To extinguish a fire in a battery room containing lead acid batteries, use CO₂, foam, or dry chemical extinguishing media. Do NOT discharge the extinguisher directly onto the battery. The resulting thermal shock may cause cracking of the battery case/cover.

SPECIAL PROCEDURES:

If batteries are on charge, shut off power. Use positive pressure, self-contained breathing apparatus. Water applied to electrolyte generates heat and causes it to splatter. Wear acid-resistant clothing.

TOXIC FUMES:

Burning plastic may cause toxic fumes. Leave area as soon as possible if toxic fumes are present. Wear breathing apparatus if required to remain in the area.



2.3.3 Electrical Shocks and Burns

Multi-cell battery systems can attain high voltage and/or currents. Do NOT touch uninsulated batteries, connectors or terminals. To prevent serious electrical burns and shock, use EXTREME CAUTION when working with the system.



Always wear protective clothing and use nonconductive or insulated tools when working with ANY battery system.

Remove all jewelry that could produce a short circuit.

BEFORE working on the system:

1. Disconnect ALL loads and power sources to the battery. Use appropriate lockout/tagout procedures.
2. If working on an assembled battery system, sectionalize (interrupt the battery in sections) into safe working voltage levels.
3. Check the battery system grounding. Grounding of the battery system is NOT recommended. However, grounding of the rack is recommended.

IF BATTERY SYSTEM IS GROUNDED (system is intentionally grounded by connecting a battery terminal to ground):



1. an increased shock hazard exists between the terminal of opposite polarity and ground (i.e., dirt and acid on top of battery cell touching rack).



2. if an unintentional ground develops within the already grounded system, a short circuit may occur and cause explosion or fire.

IF BATTERY SYSTEM IS UNGROUNDED (system is NOT grounded):



1. if an unintentional ground develops within the system, an increased shock hazard exists between the terminal of opposite polarity and ground.



2. if a second unintentional ground develops within the already unintentionally grounded system, a short circuit may occur and cause explosion or fire.

Therefore, should you be required to work on a grounded battery system, make absolutely sure you use the correct safety precautions, equipment and clothing.

IMPORTANT!!

If you have ANY question concerning safety when working with the battery system, contact your local EnerSys sales/service representative to clarify any of the noted safety precautions, or, call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems and Services.

3.0 INSPECTING BATTERY SHIPMENT

3.1 General

Precautions have been taken to pack the cells/battery units for shipment to ensure its safe arrival. However, upon receipt, you should inspect for evidence of damage that may have occurred during transit.



WARNING

**During inspections, take precautions against electrical shock.
You are handling LIVE batteries.**

3.2 Visible External Damage

IMMEDIATELY upon delivery (while the carrier representative is still on-site), inventory all materials against the Bill of Lading and inspect for visible external damage.

Check material quantities received against the Bill of Lading, including the number of battery pallets and the number of accessory boxes.

Note any:

- damage to packing material.
- wetness or stains, indicating electrolyte leakage.

If damage is noted:

1. Make a descriptive notation on the delivery receipt before signing.
2. Request an inspection by the carrier.
3. File a damage report.

3.3 Concealed Damage

Within 15 days of receipt (or as soon as practical), unpack the cells and check for concealed damage. Remember, you are handling a **LIVE** battery. Take precaution against a shock hazard. Follow all safety precautions as noted in Section 2.0.



Examine the electrolyte level to ensure that none has been spilled. If electrolyte has been lost in transit and the level is less than ½" (12 mm) below the top of the plates, add Battery Grade sulfuric acid electrolyte of the nominal operating specific gravity indicated on the cell nameplate, and bring to the low level line on open circuit.

If the electrolyte level is more than ½" (12 mm) below the top of the plates, request an inspection by a representative of the carrier and file a claim for concealed damage.

NOTE: For export, cells are usually shipped assembled, charged and dry with separate electrolyte. Fill when ready to place in service, not before. Refer to Section 12.6, "Filling and Charging Moist-Charged Cells".

Check the received materials against the detailed packing list to verify receipt of all materials in the quantities specified.

DELAY IN NOTIFYING THE CARRIER MAY RESULT IN LOSS OF YOUR RIGHT TO REIMBURSEMENT FOR DAMAGES. Refer to the Bill of Lading, if, when performing the parts inventory, you are unsure about the appearance of a part.

If you have questions concerning potential damages, contact your local EnerSys sales/service representative, or, call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems and Services.

4.0 BATTERY STORAGE BEFORE INSTALLATION

4.1 General

Batteries should be unpacked, installed and charged as soon as possible after receipt. However, if this is impractical, follow the instructions below for storing the battery before installation.

Store batteries indoors in a clean, dry and cool location. Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and life.

Do **NOT** stack pallets. **DAMAGE MAY OCCUR AND THE WARRANTY WILL BE VOIDED.**

4.2 Storage Interval

Do NOT store flooded batteries longer than the following intervals without giving periodic freshening charges. Use date of battery shipment to determine freshening charge requirements.

- Lead Antimony — every three months.
- Lead Calcium — every six months.

Storage times exceeding the above may result in plate sulfation, which may adversely affect electrical performance and expected life.

Give the battery a *freshening charge* before the end of the recommended storage interval. See Section 8 for charging information.

Repeat the *freshening charge* for each additional storage interval until the battery is installed.

Maximum total storage time before installation is two years from date of shipment from the factory to the customer. *Freshening charges* are required a minimum of every three to six months during the storage time period, as noted above.

4.3 Advance Preparation

If storage time is likely to be exceeded, make advance preparation to have an adequate charger available and adjacent to an appropriate AC supply voltage. Positioning of the cells to accept the temporary intercell connectors is another consideration of advance planning. Keep cells on styrofoam pads until they are installed on the rack.

Make every effort to get the battery connected to the charger before the expiration of the storage period, thereby avoiding the additional labor cost of preliminary freshening charges.



WARNING
FAILURE TO CHARGE AS NOTED VOIDS THE BATTERY'S WARRANTY.



**BEFORE INSTALLATION
READ THIS SECTION THOROUGHLY.**

5.0 INSTALLATION CONSIDERATIONS

5.1 General

If you have any questions concerning the installation considerations, contact your EnerSys sales/ service representative.

When planning the system space requirements for the EnerSys flooded stationary batteries, consider the following:

- space
- environment
- temperature
- distance from operating equipment
- ventilation
- battery system configuration
- floor loading
- floor anchoring

Use Table 5.1 to ensure that all requirements for installation location are considered.

TABLE 5.1	
CONSIDERATION	RECOMMENDATION
Space	<p>The aisle space provided in front of all racks should be a minimum of 36" (915 mm), where this dimension is not in conflict with any local codes or regulations.</p> <p>A minimum of 9" (230 mm) is desirable above the tops of the cell posts of the top row of cells to permit access for maintenance or cell removal.</p> <p>Each cell should be accessible for the addition of water and for taking individual cell voltage and hydrometer readings.</p>
Environment	<p>Clean, cool and dry. The location should be selected to keep water, oil, and dirt away from all cells.</p>
Temperature	<p>Ambient temperature between 72°-78° F (23°-26° C).</p> <p>Elevated temperatures reduce operating life. Lower temperatures reduce battery performance.</p> <p>Minimize temperature variations between the cells.</p> <ul style="list-style-type: none">• To avoid temperature variation between the cells, do NOT locate the battery near HVAC ducts or exhausts, heat sources (i.e., equipment that generates heat) or direct sunlight.

TABLE 5.1 (continued)

CONSIDERATION	RECOMMENDATION
<p>Ventilation</p>	<p>Adequate ventilation <u>must</u> be provided, so as to prevent hydrogen gas from exceeding a 2% concentration as shown in IEEE 484-1987.</p> <p>Hydrogen accumulation must be limited to less than 2% of the total volume of the battery area.</p> <p>Ventilation must be adequate to ensure that pockets of trapped hydrogen gas do not develop, particularly at the ceiling.</p> <p>See Appendix for additional information.</p>
<p>Grounding</p>	<p>It is recommended that the racks be grounded in accordance with NEC and/or local codes.</p>
<p>Codes</p>	<p>Building codes and fire codes may require a spill containment system for battery installations. Please consult local building codes. EnerSys offers spill containment systems. Contact your EnerSys sales/ service representative for more information.</p>
<p>Floor</p>	<p>Reasonably level. Shimming up to 1/4" (6 mm) maximum to level battery front to rear and side to side. Capable of supporting the weight of the battery as well as any auxiliary equipment.</p>
<p>Anchoring</p>	<p>Anchoring should meet all local, state, federal codes and industry standards.</p> <p>Floor anchoring and its design are the responsibility of the installer.</p>
<p>Racks</p>	<p>EnerSys flooded stationary batteries designed for racks or cabinets should be installed on racks specifically designed for those batteries by the manufacturer. Use of another rack design is the responsibility of the user.</p>

5.2 Considerations for Connecting the Battery System to Operating Equipment

The battery has been sized based on a specific load (amps or KW) for a specific run time to a specific end voltage. Consult with the system/equipment supplier to determine these parameters, because battery performance is based on these values, which are measured at the battery terminals.

Therefore, ensure that the load cables:

- between the battery and its load are the shortest routing possible to the terminal, allowing sufficient additional cable (about 6"/15 cm) for connect/disconnect.
- are the proper size to minimize the voltage drop between the battery output terminals and the load.

To select the proper cable size:

1. Determine the cable size necessary to carry the design load.
2. Calculate the voltage drop of the cable between the battery terminal plate and the operating equipment.
3. Increase cable size to achieve the allowable voltage drop.

Cable selection should provide no greater voltage drop than required between the battery system and the operating equipment as determined by the equipment/system supplier. Excessive voltage drop will reduce the desired support time of the battery system.

5.3 Considerations for Parallel Installation

If it is necessary to connect the battery system in parallel to obtain sufficient capacity, cable connections to each of the parallel strings are important.

To obtain:

- proper load sharing on the discharge
- satisfactory recharge, and
- the same float voltage for each string

cables from the batteries to the load must be:

- as short as possible (equal to the longest intercell connector).
- of equal lengths to the load (do not exceed cable ampacity).
- of sufficient ampacity.

6.0 UNPACKING AND HANDLING FOR INSTALLATION

6.1 General

Batteries are shipped assembled, charged, and filled with the electrolyte near the low level lines marked on the jar. If the electrolyte level is above the low level line on open circuit, electrolyte must be removed to avoid flooding during freshening charge.

All accessories for installation and use are supplied as optional prepackaged kits. Cells may be packed in wooden boxes, which must be opened completely and carefully. The cells are then handled as described in Section 6.3.

6.2 Recommended Installation Equipment and Supplies

Before working with the battery system, be sure that you have the proper protective clothing, safety equipment and insulated tools as specified in Section 2.0. Additional equipment for the installation of the battery system is listed in Table 6.1.

TABLE 6.1	
EQUIPMENT REQUIRED	CHECK IF ON HAND
Forklift or Portable Lift Crane	
Chalk Line	
Torpedo Level (Plastic)	
Torque Wrench (10-200 in-lbs)	
Torque Wrench (50-100 ft-lbs)	
Drift Pins	
Floor Anchors (User-supplied per battery system and attached stress analysis)	
Floor Shims (User-supplied)	
3/8" Drive Ratchet Wrench with Minimum 3" Extension With 3/8" thru 11/16" Sockets	
Box Wrenches (3/8" to 11/16")	
Screwdrivers	
Wipes, Paper or Cloth	
Plastic Bristle Brush or Nonmetallic Cleaning Pad	
Tape Measure (Nonmetallic)	
Safety Equipment and Clothing	
Small Paint Brush	
Standard Allen Wrench Set	
NO-OX-ID Grease	



Be sure you have all the proper protective clothing and safety tools and equipment on hand before starting the installation.



6.3 Cell/Jar Handling

To prevent damage to the cells and personal injury when moving/handling the batteries, follow the procedures in this section. For ease of explanation, lifting/handling instructions are grouped into three categories depending on the size of the units:

- See Section 6.3.1 — small cell handling (C)
- See Section 6.3.2 — medium cell handling (E and F)
- See Section 6.3.3 — large cell handling (D and G)

DO NOT lift any cell by the terminal posts as this will **void the warranty**. When lifting large cells/units with crane, hoist or similar device, use the lifting belt(s) and protective styrofoam shipping cover(s) provided.

DO NOT tamper with seal nuts on the cell posts as this will **void the warranty**.

6.3.1 Small Cell Handling (C)

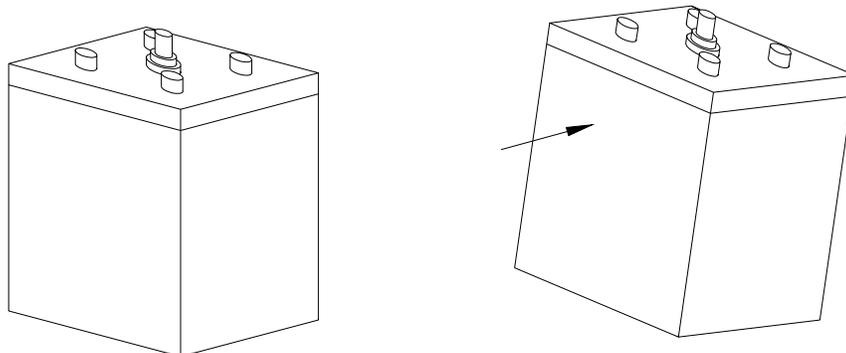
1. Lift and move these batteries manually.
2. Position hands under the bottom of the cell/jar to lift it, and place the cell/unit in the desired location.

6.3.2 Medium Cell Handling (E and F)

Never lift a cell by the posts. Lifting the cell by the post can damage the seals and will **void the warranty**. When lifting medium-size cells, use the lifting belt and protective styrofoam shipping cover provided.

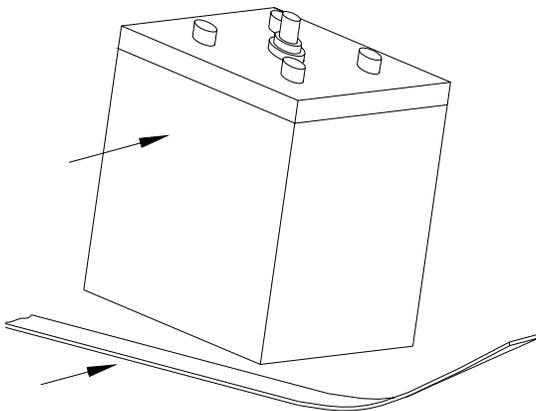
Use a mechanical device, such as a hoist or crane, for lifting.

1. Tilt the cell about 1" (25 mm) so as to position the lifting belt. See Figure 6.1.

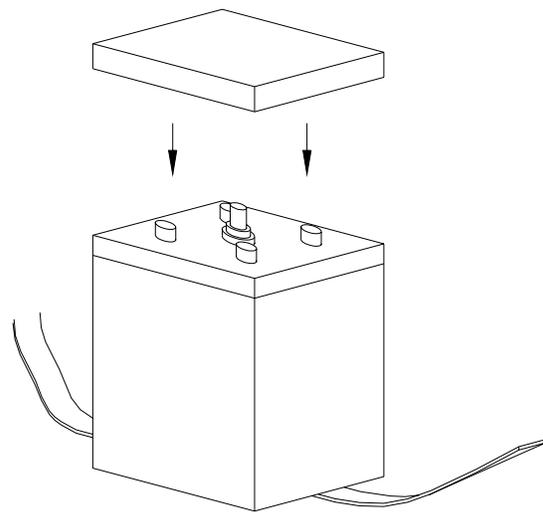


LIFTING MEDIUM-SIZE CELL
Figure 6.1

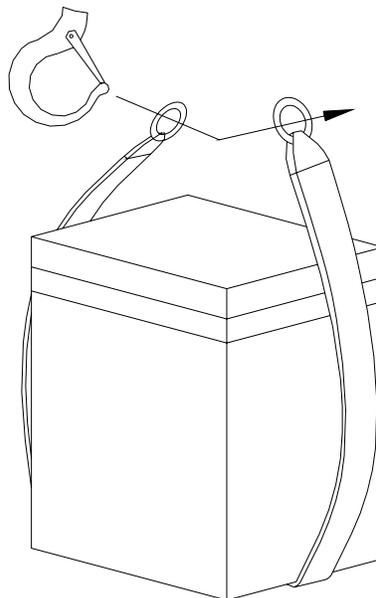
2. Slide belt underneath cell. See Figure 6.2.
3. Place the styrofoam cover on top of the cell, with the beveled ends up. See Figure 6.3.
4. Bring the end rings of the belt together over the cover and engage the hook of the lifting device in both rings. Always lift vertically and balance the cell. See Figure 6.4.
5. Remove the belt and cover after positioning the cell.



LIFTING MEDIUM-SIZE CELL
Figure 6.2



LIFTING MEDIUM-SIZE CELL
Figure 6.3



LIFTING MEDIUM-SIZE CELL
Figure 6.4

6.3.3 Large Cell Handling (D and G)

Cells are shipped on a pallet, with each cell packaged in an individual styrofoam shipping base and top.

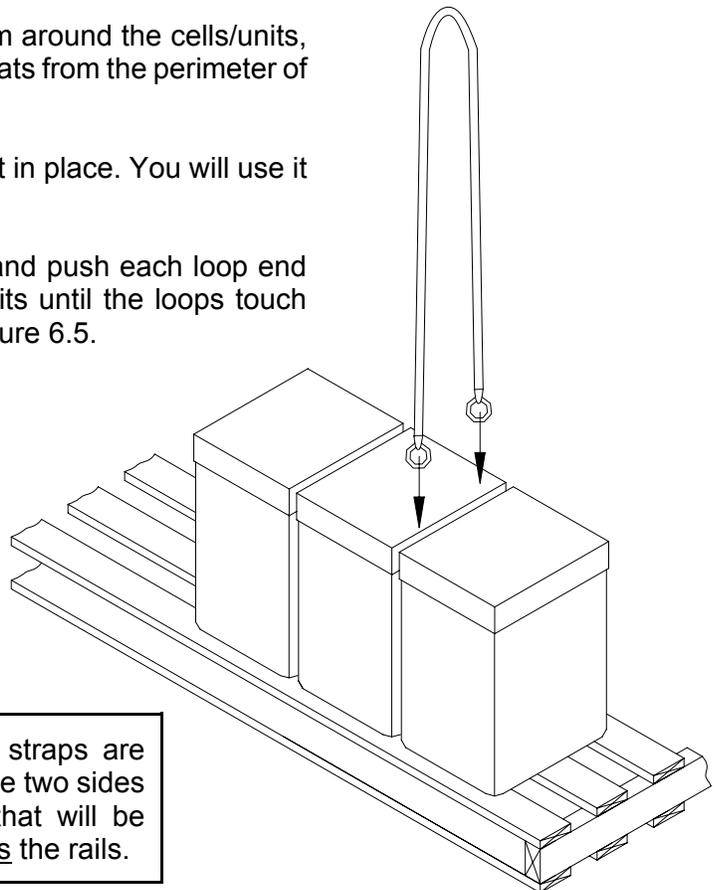
Never lift a cell by the posts. Lifting the cell by the post can damage the seals and will **void the warranty**. When lifting large-size cells, use the lifting belt and protective styrofoam shipping cover provided.

Use a mechanical device, such as a hoist or crane, for lifting.

Each battery shipment includes one lifting belt about 14 feet (4.3 meters) long x 1" (25 mm) wide.

All cells are shipped with a molded styrofoam insert covering the posts and intercell connectors. This insert should remain in place for lifting the cells. As the cell is lifted, the belts will tighten against the shipping top. The belts will cut into the styrofoam. This is desirable, because the indentations created will help to keep the belts positioned and the cell stable.

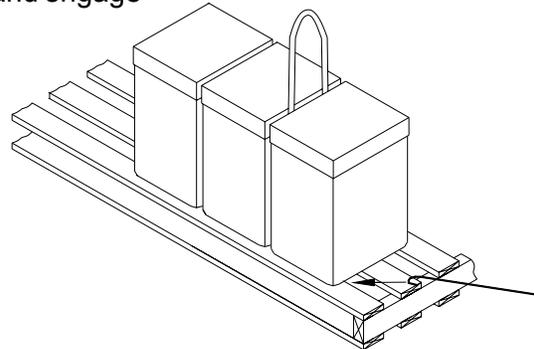
1. Remove the packaging from around the cells/units, and remove the wooden cleats from the perimeter of the shipping pallet.
2. Leave the molded top insert in place. You will use it in lifting the cell.
3. Fold the lifting belt in half and push each loop end down between the cells/units until the loops touch the shipping pallet. See Figure 6.5.



NOTE: Ensure that the straps are placed around the two sides of the cell/unit that will be positioned across the rails.

LIFTING LARGE-SIZE CELL
Figure 6.5

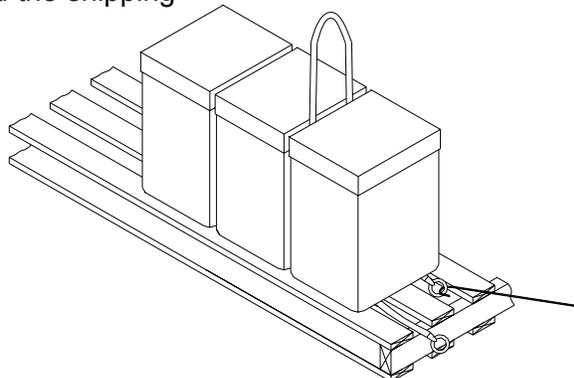
4. Use a 24" (600 mm) length of stiff wire with a hook formed on one end. Insert the hook end through the slot between the bottom of the jar and the shipping base (on the opposite side from the belt) and engage one of the loop ends with the hook. See Figure 6.6.



LIFTING LARGE-SIZE CELL

Figure 6.6

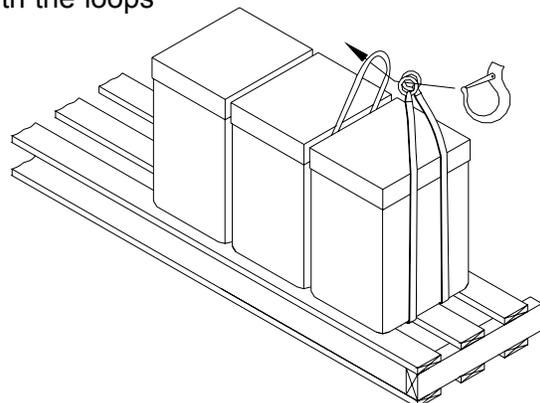
5. Pull this loop end of the belt from under the cell and out through the slot. Disengage the wire hook from the loop and again insert the hook through a different slot between the bottom of the jar and the shipping base. See Figure 6.7.



LIFTING LARGE-SIZE CELL

Figure 6.7

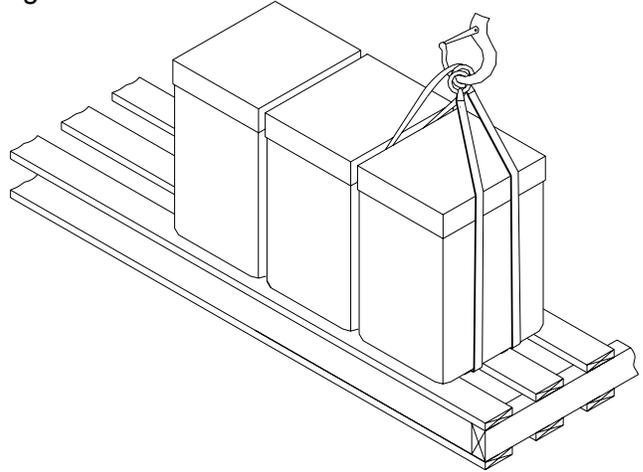
6. Engage the other belt loop with the wire hook and pull it out through the slot on the same side. Adjust the belt until the middle loop is even with the loops on the two free ends. See Figure 6.8.



LIFTING LARGE-SIZE CELL

Figure 6.8

-
7. Place the loops on the two free ends of the belt over the hook of the lifting device, and then place the middle loop over the hook. See Figure 6.9.



LIFTING LARGE-SIZE CELL
Figure 6.9

Be sure the belt is not twisted. Straighten the belts down each side and under the bottom of the cell/unit, so that they are parallel with each other. The space between the belts should be the same as the distance between the belt notches on the edge of the styrofoam. Correct belt spacing is important because it permits removal of the belt after the cell/unit has been placed on the rack rails.

8. Lift cell into position and remove belt.

Exercise extreme care when initially lifting cells and when lowering them into final position on the rack. To prevent one end of the unit from "kicking out," assign one person to steady the unit on a level plane during the entire lifting procedure.

7.0 SYSTEM INSTALLATION

EnerSys flooded batteries are installed on racks that differ in type, size, seismic rating, and configuration. Refer to the *RACK ASSEMBLY DRAWING* for the details of your installation.

7.1 System Layout

Before installing the battery system, lay out the system and consult Section 5.0 for installation considerations.

1. Locate the system position in the area designated as determined in Section 5.0.
2. Mark floor with system outline dimensions.
3. Using *RACK ASSEMBLY DRAWING* and rack components, locate the position of the floor anchors.

Floor anchors are the responsibility of the user. Follow the installation instructions of the manufacturer.

The floor must be level. Shimming up to 0.25 in. (6 mm) maximum may be required to have the Battery System fully level.

NOTE: The floor must be capable of supporting the weight of the Battery

The Battery Rack must be securely anchored to the floor. Anchoring should meet all local, state and/or federal codes. **Floor anchoring and its design are the responsibility of the installer. Ensure seismic requirements are considered.**

4. Batteries should be kept in the original shipping containers until installed. However, if you must remove the batteries before installation, see the procedures in Section 6.3, "Cell/Jar Handling."

7.2 Installation Considerations

7.2.1 Installation Precautions

1. Install the system in a well-ventilated location; allow at least 10 cm (4 inches) on all sides for air ventilation and maintenance.
2. Install the unit in a stable, level and upright position which is free of vibration.
3. Install the unit where the ambient temperature is within the correct operating range.
4. Do not install the Battery System in areas that are subject to high humidity.
5. Do not allow direct sunlight to shine on the system.
6. Do not install the Battery System in areas that are subject to contamination such as high levels of airborne dust, metal particles or flammable gasses.
7. Avoid installation near sources of electrical noise and always make sure that the unit ground is intact to prevent electrical shock and to help reduce electrical noise.
8. Do not install where water, any foreign object or substances may get inside the Battery System.

NOTE: Contact your nearest EnerSys sales/service representative when paralleling Battery Systems, to ensure compatibility of mating different batteries. Or, call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems & Services (EIS&S).

7.2.2 Arrangement

Arrange the cells so that the positive terminal of one cell/jar will be adjacent to the negative terminal of the next cell/jar throughout the battery.

Cells/jars are usually positioned on rack rails with plates perpendicular to the rails. However, F and large G cells are also positioned with plates parallel to the rails.

Take care when positioning cells to ensure that main battery terminals are not close together on step or back-to-back racks.

7.2.3 Spacing

Maintain proper spacing between cells/jars on the rack to provide thermal management and ensure proper fit of hardware connections. Position cells/jars such that the following spacing is maintained between the covers of adjoining units:

C	0.5 inches (12.7mm)
D, E, F, and G	0.25 inches (6.4mm)

7.3 Battery Installation

To install an EnerSys battery system, follow the procedures below:

1. Install the rack according to the rack assembly information detailed in “*Instructions for Assembling and Maintaining Standard and Seismic Battery Racks*” or “*Instructions for Assembling Seismic Racks*” (included with the rack shipment).
2. Before lifting cells/jars, determine which two sides will be positioned across the rails.
3. Employ the appropriate lifting/handling method for the cells to be installed (as described in Section 6.3).



WARNING

Allowing the cell/unit to drop quickly, may damage the internal cell components.

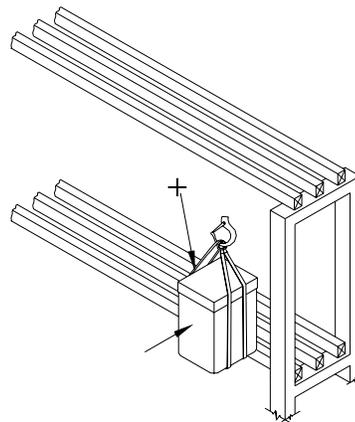
Exercise extreme caution when initially lifting cells and when lowering them into final position on the rack. To prevent one end of the unit from “kicking out,” assign one person to steady the unit on a level plane during the entire lifting procedure.

4. Position the first cell/jar on the bottom shelf, centered across the rails. After placement, remove the lifting belt (if used) from the hook and pull the belt from under the module. Also remove any remaining protective packing covers. See Figure 7.1.



WARNING

Improper lifting may result in damage to the module or in personal injury.



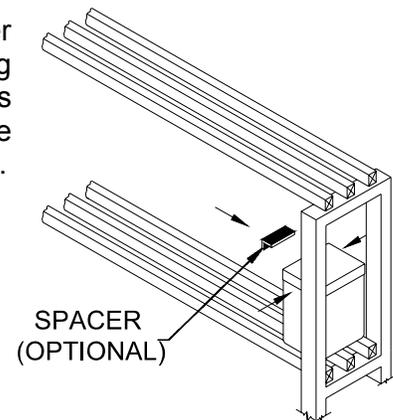
CELL/JAR PLACEMENT

Figure 7.1

To lubricate the rack rails for sliding cells into position, use only EnerSys Pro-Slide or Dow Corning Silicon Compound #111.

When sliding the cells on the lubricated rails, Do NOT push on the center of the cell/unit. Hold the cell by placing hands on the corners of the jar and then push to slide.

5. If provided, place the long rubber angle cell spacer on the mid-point of the cell cover. Position one leg on top of the cover and the other so that it extends down over the edge of the cover to the side where the next cell/jar is to be positioned. See Figure 7.2.



SPACER
(OPTIONAL)

CELL/JAR PLACEMENT

Figure 7.2

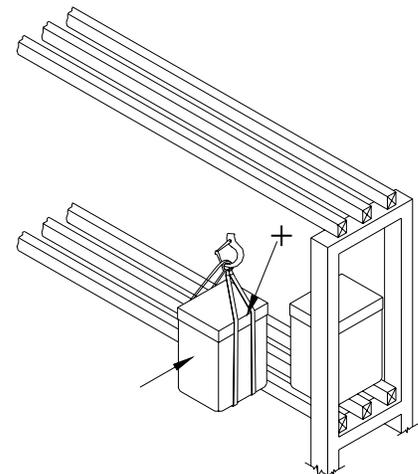
6. Lift the next cell/jar to be installed and place it next to the previously installed unit. Be certain to allow proper spacing between cells/jars as outlined in Section 7.2.2.



Exercise extreme care when positioning cells. Bumping or scraping a cell against the adjacent cell/unit or rack member may damage the jar material.

Do NOT use any kind of tool to pry cells into position.

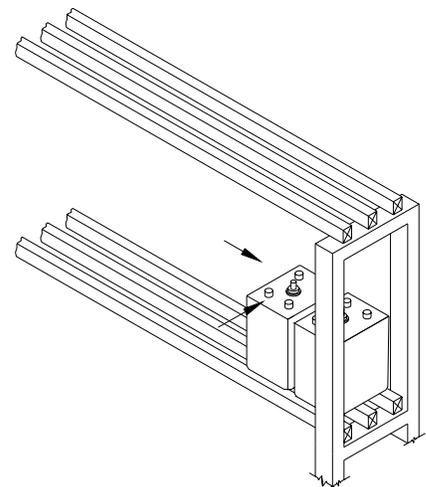
Take care to position cells so that main battery terminals are not close together on step racks or on back-to-back racks. See Figure 7.3.



CELL/JAR PLACEMENT

Figure 7.3

7. Remove the belt loops (if used) from the lifting hook and pull the belt free from under the unit. Also remove any remaining protective packing covers. See Figure 7.4.



CELL/JAR PLACEMENT

Figure 7.4

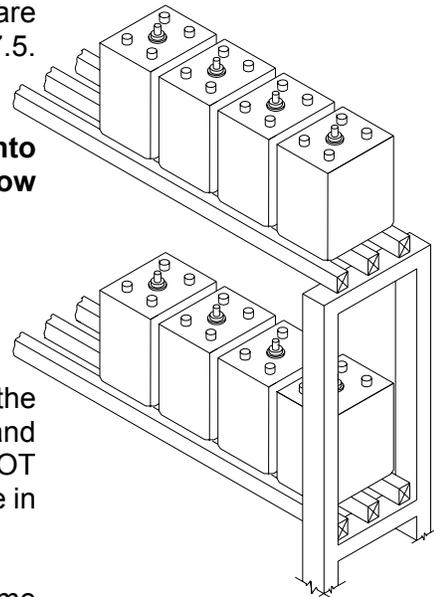
- Repeat **Procedures 5 thru 7** until all units are installed on all tier/steps of the rack. See Figure 7.5.

To lubricate the rack rails for sliding cells into position, use only EnerSys Pro-Slide or Dow Corning Silicon Compound #111.

- As soon as cells are unpacked and installed on the rack, remove the shipping vent plugs and immediately install the flame arrestors. **DO NOT** attempt to charge cells unless flame arrestors are in place.

Once installed, **DO NOT REMOVE** the flame arrestors. They are provided with a filling funnel for adding water and measuring the electrolyte temperature. Do not permit the electrolyte level to drop below the bottom of the tube on the flame arrestor. Allowing too low a level defeats the flame arrestor function.

- Number the cells starting from the positive terminal of the battery. The cell numbers supplied are backed with pressure-sensitive adhesive and should be applied to the rails or the jars. Before applying the cell numbers, clean surfaces according to Procedure 3 in Section 12.1.1.



FULL RACK OF CELLS
Figure 7.5

7.4 Preparing and Installing Connections

The cells are now positioned and ready to be connected.

Before preparing and making the connections, heat NO-OX-ID grease in hot water as necessary to soften for application with a paintbrush.

7.4.1 Terminal Posts

All terminal posts of the cells are greased at the factory to prevent oxidation.

1. Remove the grease with a paper towel.
2. Inspect each terminal post. If discoloration or tarnishing is noted, neutralize the post with sodium bicarbonate and water solution (Section 12.1.2, Procedure 2). Dry thoroughly.
3. Clean the contact surface with a stiff-bristle nonmetallic brush/pad until a clean, bright surface is obtained. Do NOT expose copper.
4. Apply a light coat of NO-OX-ID grease.

7.4.2 Intercell Connectors

The connections are made by bolting the lead-plated copper intercell connectors to the cell posts of opposite polarity on adjacent cells. When more than one intercell connector per cell is furnished, bolt the connectors on opposite sides of the cell posts.

1. Clean the contact surface of the intercell connector using a stiff bristle nonmetallic brush/pad.

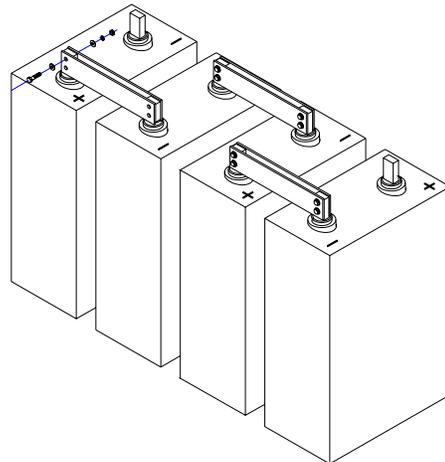
Use care so as NOT to remove the lead plating and expose any copper.

2. With a small paintbrush, apply a light coat of heated NO-OX-ID grease to the contact surface of the intercell connector.

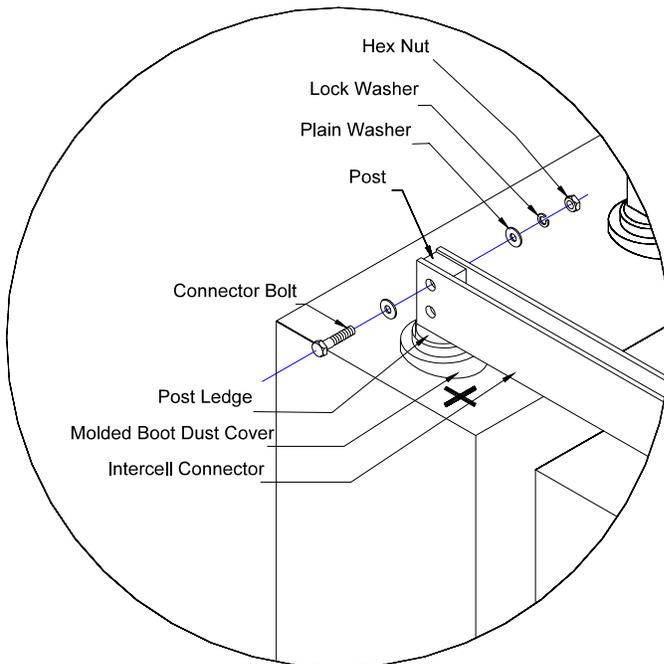
3. Bolt all intercell connectors and assemble as shown in Figures 7.6 and the detail.

Certain intercell connectors (such as those for all “G” cells) are furnished with the bolt holes located off-center. Install these connectors so that the bottom edge of the connector does not interfere with the post ledge (Figure 7.6 and the detail).

 **Stamped flat washers may have one sharp edge. Install with this edge away from the lead plated copper intercell connector to avoid damaging the lead plating.**



BOLTING INTERCELL CONNECTORS
Figure 7.6



BOLTING INTERCELL CONNECTORS
Figure 7.6
Detail

4. Secure all connections finger-tight to allow for some adjustment of position.
5. After all connections are completed, torque all stainless steel connector bolts according to Table 7.1.

TABLE 7.1		
316SS Bolt Size Diameter x Threads/Inch	Initial Torque Value Inch-Pounds (Newton Meter)	Retorque Value Inch-Pounds (Newton Meter)
1/4 - 20	70 - 75 (8.0 - 8.5)	60 - 65 (7.0 - 7.5)
5/16 - 18	120 - 125 (13.6 - 14.1)	110 - 115 (12.5 - 13.0)
1/2 - 13	130 - 135 (14.7 - 15.3)	120 - 125 (13.6 - 14.1)



Make sure that all bolted battery connections are torqued to the recommended values. The increased resistance of a loose connection can generate heat and become a fire hazard.

6. Apply a light coat of heated NO-OX-ID grease to the bolted connection with a small paintbrush in the area of the terminal post only.

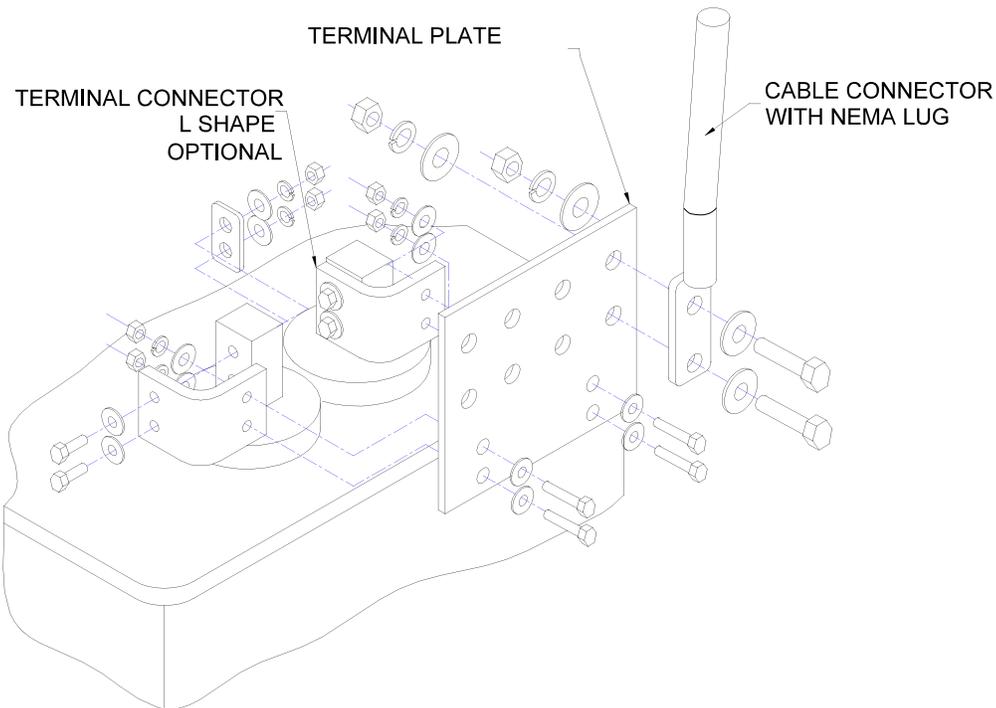
7.4.3 Terminal Plates

Terminal plates are supplied with the battery system to provide a system connection point (except for “C” line). All system connections must be made to the terminal plate and NEVER to the cell terminal post (except for “C” line).

1. Clean the electrical contact areas of the terminal plate, terminal connectors, and cell/jar posts with a stiff-bristle nonmetallic brush/pad until the surface is bright. Be careful not to remove the lead plating with excessive brushing.

A typical terminal plate is illustrated in Figure 7.7.

2. With a small paintbrush, apply a light coating of heated NO-OX-ID grease to contact areas.
3. Install terminal connectors to cell posts. Tighten connections according to the torque values in Table 7.1.



TERMINAL PLATE INSTALLATION
Figure 7.7

-
4. With a small paintbrush, apply a light coat of heated NO-OX-ID grease to the electrical contact areas of the terminal plate.
 5. Install the terminal plate to the terminal connectors using the torque values in Table 7.1.
 6. Connect the positive lead from the charger to the positive terminal plate of the battery and the negative lead from the charger to the negative terminal plate of the battery. (Some seismic installations have interface connections.)
 7. Connectors to battery terminal plates should be flexible, since rigid terminal connectors may transmit vibrations or strain to cell posts that could result in loose connections. Support cables so that the cell post does not bear the load.
 8. **Before activating the charger:**
 - a. Inspect the cell connections of the system to ensure that all cells are connected correctly, POSITIVE (+) to NEGATIVE (-).
 - b. Measure the voltage across the system terminals. Voltage of the battery should equal approximately 2.15 times the number of cells in the string.
 - c. Measure and record the resistance of cell-to-cell and cell-to-terminal connections. If the resistance of any connection is more than 10% above the average, unbolt and remove the affected connectors and follow the cleaning procedure in Section 12.1.3. Then remake the connection.

NOTE: Do NOT recalculate the average resistance and do NOT repeat the cleaning procedure.

8.0 INITIAL and/or FRESHENING CHARGE

Batteries lose some initial charge during shipment and storage. Depending on storage time, a battery may require a *freshening charge*. See Section 4.0 for battery storage times.

Before switching on the charger, ensure that shipping vent plugs are removed and flame arrestors are installed.

Do NOT attempt a freshening charge unless the electrolyte levels are near the low level line on open circuit. When necessary, remove electrolyte to that level from cells with high levels.

Most chargers of modern design utilize the principle of constant voltage (potential) charging. The preferred charge method is to use a constant voltage of 2.50 volts per cell times the number of cells. If this voltage is too high for the equipment (load) connected to DC bus, then use lower acceptable voltage. See Table 8.1. Should the charge current cause electrolyte flooding out onto the cover, reduce the charge voltage at once.

Least desirable is to put the battery on float - particularly for calcium alloy cells. Equalize charging at 2.33 volts per cell is the minimum acceptable procedure.

1. Determine the maximum voltage that may be applied to the system equipment (or maximum charger voltage if load is not yet connected). Refer to the recommendations of the manufacturer/supplier of system equipment, connected to DC bus.
2. Divide the maximum total system voltage by the number of cells (not units) connected in series. This is the maximum volts per cell that may be used for the initial charge.
3. Check the nameplate to determine whether the battery is of a lead-antimony type or a lead-calcium type.
4. Connect battery positive (+) terminal to charger bus positive (+) terminal.
5. Connect battery negative (-) terminal to charger bus negative (-) terminal.

6. Raise the voltage to the maximum value permitted by the equipment as shown in Table 8.1.

Table 8.1 lists the hours of freshening charge to be given after charge current has stabilized for 24 hours.

TABLE 8.1					
MINIMUM HOURS OF CHARGE AFTER CURRENT STABILIZATION					
Alloy	Antimony		Calcium		
Sp. Gr.	1.215	1.250	1.215	1.250	1.300
V.P.C.					
2.27	140	210			
2.30	100	150			
2.33	70	110	140		
2.36	50	78	100	160	
2.39	35	56	70	110	
2.42	25		50	80	125
2.45	24		40	55	85
2.50	22		36	50	60
2.60			30	44	50
2.70			24	36	44

Table 8.1 applies for cell temperatures between 60°F to 90°F (16°C to 32°C). For cell temperatures 40°F to 59°F (5°C to 15°C), use twice the number of hours. For cell temperatures 39°F (4°C) or below, use four times the number of hours.

On “C,” “D,” “E,” “F,” and “G” cells, you may insert the thermometer in the funnel of the pilot cell's flame arrestor and leave it there by adjusting the rubber washer to the correct height and leaving off the dust cap. **DO NOT LEAVE thermometers in place in seismic regions.**

7. When charging current has decreased and stabilized (i.e. no further reduction for 24 hours), charge for the hours shown in Table 8.1.



Monitor the battery temperature during the charge. If the battery exceeds 110°F (43°C), stop the charge immediately and allow the temperature to decrease below 100°F (38°C). Failure to follow this warning may result in severe overcharge and damage to the cell/battery.

9.0 OPERATION

9.1 Float Operation

In this type of operation, the battery and the critical load circuits are continuously connected in parallel with a constant voltage charger. The charger must be capable of:

- charging the battery from the discharged condition while supplying the DC power to the connected DC load
- providing the required constant float voltage
- providing voltage for equalizing the battery

Float voltage sustains the battery in a fully charged condition and makes it available to provide the emergency power required in the event of an AC power interruption or charger failure.

The table below lists the recommended average float volts per cell for nominal specific gravities used in stationary service.

TABLE 9.1			
RECOMMENDED AVERAGE FLOAT VOLTS PER CELL FOR NOMINAL SPECIFIC GRAVITIES			
Nominal Specific Gravity	Suffix	Average Float Volts per Cell	
		Antimony	Calcium
1.250	B	2.17 - 2.21	2.21 - 2.30
1.215	None	2.15 - 2.20	2.17 - 2.26

An equalizing charge should be given when:

- the temperature corrected specific gravity has fallen more than 10 points (.010).
- one or more cells fall below the following critical voltages on float, corrected for temperature. (Refer to Section 9.4 for equalizing charge.)

TABLE 9.2	
MINIMUM TEMPERATURE — CORRECTED FLOAT VOLTAGES	
Nominal Specific Gravity	Cell Voltage
1.215	2.13
1.250	2.14

9.2 Hydrometer Readings - Specific Gravity

Specific gravity is a measurement of the density or weight of the electrolyte compared with water (1.000). Specific gravity decreases on discharge and rises again on charge as a result of the electrochemical reaction within the cell.

Because both the cell temperature and the electrolyte level affect the specific gravity reading, they should be recorded at the same time as the gravity reading.

Do not take gravity readings immediately after adding water to the cells. Complete mixing usually takes several days for antimony cells and several weeks for calcium cells. Because of the low charging currents in float service, especially with lead calcium cells, mixing of the electrolyte is a very slow process.

Calcium cells are provided with an electrolyte withdrawal tube, located in the corner of the cell cover adjacent to the positive post(s). Other corner holes are sealed off with plugs. Keep these plugs tightly closed and do not open them to withdraw acid sample. "C" size cells do not have an acid withdrawal tube.

Antimony cells are not provided with an electrolyte withdrawal tube. To take a specific gravity reading, use the flame arrestor's center funnel. Access this funnel by removing the dust cap of the flame arrestor. **(All the corner holes are sealed with plugs. Keep these plugs tightly closed and do NOT open them to withdraw acid sample.)**

Using the long-stemmed hydrometer (Cat. 81332) will result in sampling of the electrolyte at a point one-third down from the top of the plate. The long stem of the hydrometer must be cut to 7 3/4" (200 mm) for "E" cells; to 9" (230 mm) for "D" and "F" cells; or 12" (300 mm) for "G" cells. At this level the electrolyte gives a reliable indication of the state of charge of a cell.

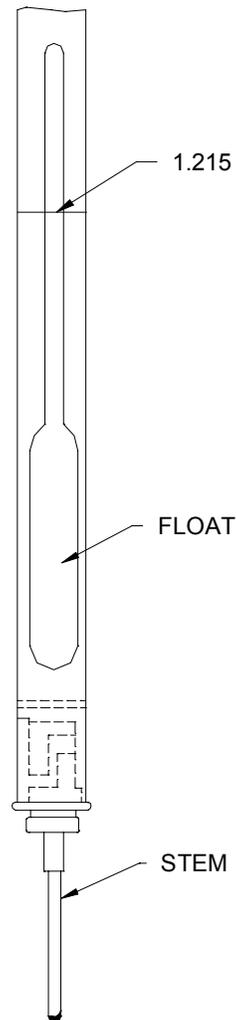
When taking a hydrometer reading, insert the full length of the hydrometer stem into the withdrawal tube hole, so that the base of the stem rests on top of the withdrawal tube.

9.3 Full-Charge Specific Gravity

With the cells fully charged, the electrolyte level at the midpoint between level lines and the cells on float for a minimum of 72 hours, the specific gravity of the electrolyte at 77°F (25°C) should read between the limits on the cell nameplate.

These gravity limits are adjusted at the factory and will not require any further adjusting during the life of the battery unless electrolyte is actually lost from a cell. If electrolyte should accidentally be lost, it should be replaced with electrolyte of the same specific gravity as that in the adjacent cells.

When taking hydrometer readings, hold the hydrometer stem in an upright position so that the hydrometer floats freely and does not touch at either the top or the sides (See Figure 9.1).



**Hydrometer
Cat. 81332**

Figure 9.1

Periodically clean the hydrometer barrel and float with soap and water for ease of reading and improved accuracy.

Specific gravity readings should be corrected for temperature. For every 3°F (1.67°C) of temperature above 77° F (25°C), add one point (.001) to the hydrometer reading. For every 3°F (1.67°C) of temperature below 77°F (25°C), subtract one point (.001) from the hydrometer reading.

9.4 Equalizing Charge

Under NORMAL conditions an equalizing charge is NOT required. An equalizing charge is a special charge given to a battery when nonuniformity in voltage has developed between cells. It is given to restore all cells to a fully charged condition.

Nonuniformity of cells may result from:

- low float voltage due to improper adjustment of the charger.
- a panel voltmeter that reads high, resulting in a low charger output voltage.
- selection of too low a float voltage.
- variations in cell temperatures in the series at a given time, due to environmental conditions or module arrangement. The maximum cell-to-cell temperature difference is 5° F (3° C). If cell temperature is the problem, review the location instructions in Section 5.0 to ensure proper location of the battery system.

9.4.1 Equalizing Charge Method

Constant voltage charging is the method for giving an equalizing charge.

Determine the equalizing voltage based on the maximum voltage allowed by the system equipment connected to the DC bus.

The charge table shown in Table 9.3 lists the minimum hours of equalizing charge to be given after the charging current has stabilized (no further current reduction for 24 hrs).

Alloy	Antimony		Calcium		
	1.215	1.250	1.215	1.250	1.300
Sp. Gr.					
V.P.C.					
2.24	100	160			
2.27	70	110			
2.30	50	78	100		
2.33	35	55	70	110	
2.36	25	28	50	80	125
2.39			35	55	90
2.42			25	40	60
2.45				28	45
2.48					30

Table 9.3 applies for cell temperatures between 60° F to 90° F (16° C to 32° C). For cell temperatures 40° F to 59° F (5° C to 15° C), use twice the number of hours. For cell temperatures 39° F (4° C) or below, use four times the number of hours.

NOTE: The voltage of a warm cell will be lower than the average. Its voltage can be corrected for temperature by adding 0.003V for each degree Fahrenheit (0.005 V/° C) that the cell temperature is above the average temperature of the other cells.

During the equalizing charge, monitor the temperature of a pilot cell. It should not rise above 110° F (43° C). If it does, the equalizing voltage should be lowered to 2.20 or 2.25 VPC until the cells cool down to a temperature of 100° F (38° C) or lower.



Failure to follow this warning may result in severe overcharge and damage to the cell/battery. At this point, the equalizing charge may be resumed.

9.5 Operating Temperature

Normal battery life may be expected only when batteries are operated under the following temperature conditions:

TABLE 9.4 — RECOMMENDED BATTERY TEMPERATURES			
Nominal Specific Gravity		Annual Average Battery Temperature	Any Cell Temp. Not To Exceed for More Than 30 Days Per Year
Calcium	Antimony		
1.215 1.250	1.215 1.250	77°F (25° C) 72° F (22° C)	90°F (32° C) 85°F (29° C)

The room air circulation should be adequate to maintain all cells in the battery within 5° F (3° C) of each other.

High temperature increases realized capacity but decreases life expectancy, while low temperatures decrease capacity, but may not affect life expectancy. Table 9.5 shows the relationship between average temperature and battery life.

TABLE 9.5 — RELATIONSHIP OF TEMPERATURE TO BATTERY LIFE			
	% of 8-Hr. Capacity	Antimony Flat Plate	Calcium Flat Plate
Approx. number of cycles at 80% discharge	—	300	50
Average operating Temp. ° F		Life Expectancy in Full Float Application (years)	
107	109	6	5
92	105	12	10
77	100	20	20
62	92	22	22
47	83	25	25

10.0 BATTERY TAPS

Connections made to a battery for tapping a certain group of cells to provide a voltage other than the total battery voltage is NOT recommended and can **void the warranty**. Tapping results in an imbalance of the system during charging and discharging, causing unsatisfactory operation.

11.0 PILOT CELL

One cell in a battery is usually selected as a pilot cell. It becomes an indicator of the general condition of the entire battery with regard to voltage, gravity and temperature. Pilot cell readings serve as an interim indicator between regularly scheduled voltage and gravity readings of the complete battery. The thermometer should be permanently mounted in the pilot cell flame arrester (except in seismic areas).

Because a small amount of electrolyte may be lost in taking hydrometer readings, you should select a different cell as the pilot cell annually.

Read and record the pilot cell voltage on a monthly basis between regularly scheduled individual cell readings.

12.0 MAINTENANCE

EnerSys also recommends to follow IEEE Std. 450 for the battery maintenance in addition to the following:

12.1 Battery Cleaning

Observe the battery for cleanliness at regular intervals. Keep cell terminals and connectors free of corrosion. Terminal corrosion may adversely affect the performance of the battery, and it could present a safety hazard.

12.1.1 Standard Cleaning

To perform a standard cleaning of the battery, follow the procedure below:

1. Disconnect the battery.
2. Wipe off any accumulation of dust on the cell covers with a cloth dampened with clean water.
3. If the cell covers or jars are damp with spilled electrolyte, wipe with a cloth dampened with a solution of sodium bicarbonate and cold water, mixed in the proportions of 1.0 lb/1.0 gal (0.5 kg/5.0 liter) of water. Follow this by wiping with a cloth dampened in clear water and then wipe dry with a clean cloth.



Do NOT use any type of oil, solvent, detergent, petroleum-based solvent or ammonia solution to clean the jars or covers. These materials will cause permanent damage to the battery jar and cover and will void the warranty.

12.1.2 Corrosion Cleaning

To clean mild corrosion from cell posts, follow the procedure below:

1. Disconnect the battery.
2. Remove corrosion by wiping with a cloth dampened with bicarbonate of soda solution [mix 1 gallon (4l) of water with 1 lb. (500g) of bicarbonate of soda]. Follow with a cloth dampened with clear water.
3. Dry with a clean cloth.
4. With a small paintbrush, apply a light coat of heated NO-OX-ID grease to the entire bolted connection.

12.1.3 Heavy Corrosion Cleaning



If the routine cleaning of bolted connections has been neglected, heavy post corrosion may occur. The performance of the battery under load could be adversely affected, and this condition could present a safety hazard.

To perform the heavy corrosion cleaning, follow the procedure below.

1. Arrange to maintain continuity of the circuit, if required.
2. Unbolt and remove connectors.
3. Apply a solution of bicarbonate of soda and water to the cell posts and connectors to neutralize the corrosion (as described in Section 12.1.2, Procedure 2).
4. Clean the contact surfaces by rubbing the surface of the post or terminal and lead-plated contact surfaces with a stiff-bristle nonmetallic brush/pad. **Exercise care so you do NOT remove the lead plating on the connectors, terminal plates or lugs, exposing copper.**
5. Recoat the contact surfaces with a thin application of the NO-OX-ID grease, heated to a liquid form and applied with a small paintbrush.
6. Reinstall and tighten connections to appropriate retorque value in Table 7.1.

12.1.4 Cleaning Flame Arrestors

When cells are overfilled with electrolyte (above the high level line) or are excessively overcharged, the diffuser material of the flame arrestor may become partially clogged from electrolyte spray. Replace all flame arrestors having clogged pores or clean the arrestors as follows.

Immerse the flame arrestor several times in a plastic bucket filled with fresh water. After each immersion, eject the water by vigorous shaking or with an air blast. Following the immersion of 15 flame arrestors, dump and refill the bucket with clean water.

Do not use any cleaning or neutralizing agents in the cleaning water, since any dry residue may clog the pores of the diffuser materials.

12.1.5 Replacing or Isolating a Cell

To replace or isolate a cell for maintenance, follow the procedure below.

1. Arrange to maintain the continuity of the circuit, if required.
2. Unbolt and remove connectors.
3. Remove and replace cell OR isolate the required cell.
4. Reinstall and torque connections according to Section 7.4.

12.2 Maintenance Records

A complete recorded history of the battery operation is essential for obtaining satisfactory performance. Good records will show when corrective action is required to eliminate possible charging, maintenance or environmental problems.

Should you have ANY questions concerning how to perform the required maintenance, contact your nearest EnerSys sales/service representative or call the corporate office number listed on the back of this manual and ask for EnerSys Integrated Systems and Services.

Accumulate and permanently record the following data for review by supervisory personnel so that any necessary remedial action may be taken:

The initial records are those readings taken after the battery has been in regular float service for 3 months (90 days). These should include the battery terminal float voltage and specific gravity reading of each cell corrected to 77° F (25° C), all cell voltages, the electrolyte level, temperature of one cell on each row of each rack, and cell-to-cell and terminal connection detail resistance readings. It is important that these readings be retained for future comparison.

The frequency and types of readings recorded are usually governed by the standard operating procedures and policies of the user. Adequate battery records are an invaluable aid as a check on maintenance procedures, environmental problems, system failures and corrective actions taken in the past.

The following schedule is recommended for good maintenance and records.

Monthly

- General appearance and cleanliness
- Charger output amps and volts
- Electrolyte levels
- Cracks in cells or leakage of electrolyte
- Evidence of corrosion at terminals or connectors
- Ambient temperature and condition of ventilating equipment
- Pilot cell voltage, specific gravity and electrolyte temperature
- Evidence of voltage leaks to ground

Quarterly

In addition to the monthly items also obtain and record the following:

- Specific gravity of each cell
- Voltage of each cell
- Total battery voltage
- Temperature of one cell on each row on each rack
- Randomly select and check 10% of intercell connection resistances

Annually

In addition to the quarterly items, also do the following:

- Perform detailed visual inspection of each cell
- Check all bolted connections against IEEE 450 to see if retorquing is required. Tighten all bolted connections to the retorque value specified in Table 7.1. Then obtain and record the connection resistance of cell-to-cell and cell-to-terminal.
- Check integrity of rack.

THE ABOVE FREQUENCY OF RECORD TAKING IS THE ABSOLUTE MINIMUM TO PROTECT THE WARRANTY. This data will be required for any warranty claim made on the battery. For system protection and to suit local conditions/requirements, more frequent readings (quarterly) are desirable. A sample record chart is provided on page 42. Make a copy of the chart to use for your permanent records.

12.3 Corrective Actions

Low electrolyte levels should be corrected by following the procedures given in Section 12.4 below.

If charger output voltage is not within the recommended voltage range, make adjustments. Then determine the cause of the shift and correct the problem.

Keep cells clean, terminal posts and connectors corrosion-free, and grounds eliminated by following the procedures in Section 12.1.

When cell temperatures deviate more than 5° F (3° C) from each other during an inspection, determine the cause and correct the problem.

When the connection resistance value of any intercell or terminal connection exceeds the installation base value by more than 20%, this must be corrected using the procedures in Section 12.1.3.

12.4 Adding Water

Cells on charge normally show a very gradual lowering of the electrolyte level over a period of time, due to a loss of water from the electrolyte. Hydrogen and oxygen gasses are liberated by electrolysis as a result of charging current. Cells also lose water from normal evaporation at a rate relative to the cell temperature and the humidity.

At regular intervals this water loss must be replaced with distilled, deionized or approved water, so as to maintain the electrolyte level at the mid-point between the high and low level lines marked on the jar, while on float.

Cells are equipped with flame arrestors with a filling funnel. Add water through the filling funnel by removing the dust cap, but without removing the flame arrestors from the cell covers.

The best time to add water to the stationary lead-acid battery is when the recharge or equalizing charge is about two-thirds completed. In this condition the electrolyte should be brought up to the high line. Water tends to float on top of the electrolyte for awhile, but the gassing action of the latter part of the charging period will mix the water into the electrolyte. If temperatures may possibly drop below freezing, water should be added at the start of the recharge or equalizing charge to ensure thorough mixing with the acid solution.

Take care to keep the solution level below the top mark of the cell jar's solution level markings while on equalize. Overflow of solution can occur during gassing if too much water is added to the electrolyte.

Under certain conditions some batteries may never require an equalizing charge. These batteries may be watered when required. The mixing of the water with the electrolyte is a very slow process, especially with the low float currents of lead-calcium cells. In these cases realistic specific gravity readings may be obtained only after six or more weeks of charging at float voltages.

In cold climate with unheated battery rooms, water should be added only when the battery temperature is 50° F (10° C) or above.



Never add any special types of powders, solutions or jellies to the batteries.

12.5 Quality of Water

Only distilled, deionized or other approved water (Deionizer Cat. 94866, Watering Gun Cat. 92755) should be added to the battery.

Approved water is water that has been analyzed by a qualified laboratory and found safe for use with lead-acid storage batteries. Local municipal water supplies in the U.S.A. & Canada are usually satisfactory. Obtain an analysis from the local municipality to be sure the results comply with the impurity levels in Table 12.1.

Before drawing water from a tap or spigot, run the water for several minutes to clear metallic impurities from the pipes.

Do not store the water in a metal container. Use a clean container made of glass, rubber or plastic. The container should not have stored anything but water in the past.

The following table shows the maximum allowable impurities:

TABLE 12.1 — BATTERY WATER QUALITY MAXIMUM IMPURITIES	
Requirements	Maximum Allowable Limits Parts Per Million (P.P.M.)
Total Solids*	350.0
Fixed Solids*	200.0
Organic and Volatile*	150.0
Iron	4.0
Chloride	25.0
Ammonium (NH ₄)	4.0
Nitrates (NO ₂)	10.0
Nitrates (NO ₃)	10.0
Manganese	0.07
Calcium and Magnesium	40.0

* ASTM Spec. D-1888 Method A or equal

STORAGE BATTERY REPORT - Battery in Float Service

Sheet No. _____

Company _____ Batt. Type _____ Date Installed _____
 Location _____ Pilot Cell No. _____ (rotate as needed)
 Battery No. _____ Full Charge Gravity (Range) _____

Monthly							Quarterly															
DATE & INITIALS OF READER	BATT. TERM VOLTS	CHARGER		ACID LEVEL	PILOT CELL HYDRO METER READINGS	TEMPERATURES		DATE	CELL		VOLTS		HYD. RDG		VOLTS		HYD. RDG		VOLTS		HYD. RDG	
		VOLTS	AMPS			PILOT CELL	ROOM		VOLTS	HYD. RDG	VOLTS	HYD. RDG	VOLTS	HYD. RDG	VOLTS	HYD. RDG						
								1														
								2														
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Notes

Quarterly

ADDING WATER
(when required)

Add water after completing hydrometer readings.

Date _____ Quantity _____ Qts.

Annually

Connector Bolts Retorqued

Record contact resistance readings and any calculations.

Date _____ Range of Resistance Values Intercell Connectors _____

Acceptance Test Results — Date _____

Performance Test Results — Date _____

12.6 Filling & Charging Moist-charged Cells

Cells may be received moist-charged. This type of cell should be activated (filled with electrolyte and charged) only when ready to be placed in service. Moist-charged cells are active and contain charge. *DO NOT SHORT THE TERMINAL POSTS*. Moist-charged cells may be stored for up to five years without deterioration in cool, low-humidity locations. (<90° F, <50%H).

To activate the cells, remove and discard the shipping plugs or pressure-relief valves for moist-charged cells and fill the cells to the low level line with an approved grade electrolyte. Mix the electrolyte before use to eliminate stratification.

<p>NOTE: The filling electrolyte specific gravity must be 15 points (.015) less than the cell nominal specific gravity.</p>

When mixing electrolyte, always add acid to water. Pour slowly and stir constantly, to avoid excessive heat or violent chemical reaction.

Allow the battery to stand for four hours after filling. Add additional sulfuric acid of the filling electrolyte specific gravity to bring the electrolyte level up to the low level line. The charge must then be started within 12 hours.

Before charging, install the flame arrestors, and then lock in place with one quarter turn clockwise. Then install the dust cap, when provided, on each arrestor.

The preferable way to charge antimony alloy cells is a constant voltage averaging 2.50 volts per cell. For calcium alloy cells, the voltage needs to be 2.70 volts per cell for the time shown in Table 8.1.

Methods to accomplish such initial charging are:

- Parallel the battery to reduce the effective number of cells by half when the charger voltage can be reduced significantly to achieve the volts per cell specified above, or
- Charge 80% of the cells on system charger, and use an auxiliary charger to charge the remaining cells, or
- Charge about 80% of the cells from the positive end, using the maximum voltage indicated previously. Then reconnect about 80% of the cells from the negative end, and using maximum voltage indicated, charge until the remaining 20% of the cells that were not charged the first time are fully charged. Do not be concerned if 60% of the cells obtain twice the normal charge; however, they may require some additional water.



If cell temperatures exceed 110° F (43° C), interrupt the charge and wait until the temperature has dropped to 100° F (38° C). Then the charging may be resumed.

Add filling electrolyte, where necessary, so all cells are at the high level line when the activating charge is about two-thirds complete.

At the completion of the charge, the specific gravity of all cells, corrected to 77° F (25° C), should be within the range indicated on the nameplate. At the end of charge, if the specific gravity is higher, remove some electrolyte and replace with water. If lower, remove some electrolyte and replace with electrolyte of higher specific gravity. At some remote locations, electrolyte with higher specific gravity may not be available. In this case, adjust the level with electrolyte instead of water. Measure the specific gravity and keep adjusting the level with electrolyte until a normal specific gravity reading is achieved.

TABLE 12.2 ELECTROLYTE QUALITY DILUTE SULFURIC ACID (H₂SO₄) MAXIMUM IMPURITIES		
% By Weight	1.250 - 1.300 Sp. Gr.	1.170 - 1.215 Sp. Gr.
Organic Matter	None	None
Platinum (Pt)	None	None
Sulfurous Acid (SO ₂)	0.0016	0.0013
Iron (Fe)	0.0020	0.0016
Copper (Cu)	0.0001	0.00008
Zinc (Zn)	0.0016	0.0013
Arsenic (As)	0.00004	0.00003
Antimony (Sb)	0.00004	0.00003
Selenium (Se)	0.0008	0.0006
Nickel (Ni)	0.00004	0.00003
Manganese (Mn)	0.000008	0.000006
Nitrates (NO ₃)	0.0002	0.00016
Ammonium (NH ₄)	0.0004	0.0003
Chloride (Cl)	0.0004	0.0003
Fixed Residue	0.012	0.009

For test method — See Federal Specification 05-801 (latest issue)

13.0 TEST PROCEDURES

13.1 Procedure for Battery Capacity Tests

At least 3 days but not more than 7 days before a battery capacity test, give the battery an equalizing charge as described in Section 9.4.

1. Make sure all battery connections are clean, tight and free of corrosion.
2. While the battery is on float, read and record the specific gravity and voltage of each cell, the temperature of at least every tenth cell, and battery terminal float voltage.
3. Disconnect the battery charger and any other load on the battery to be tested.
4. Select the discharge rate based upon the critical load and time period. The test discharge current is equal to the rated discharge current divided by the K Factor (see Table 13.1) for the initial battery electrolyte temperature (IEEE-450-1996).
5. With the variable load bank having an ammeter in series and a voltmeter across the battery terminals, connect the load, simultaneously starting the timing device. Maintain the correct current while periodically reading and recording total battery voltage. When the minimum total voltage has been reached, it is desirable to read and record each cell voltage including an intercell connector.
6. Observe the battery for intercell connector heating.
7. Calculate the capacity using the following formula:

$$\% \text{ Capacity at } 77^{\circ} \text{ F (} 25^{\circ} \text{ C)} = \frac{T_a}{T_s} \times 100$$

Where T_a = test discharge time to specified voltage.

Where T_s = rated discharge time to specified voltage.

8. Recharge the battery, preferably using an equalizing charge (Section 9.4) to minimize the recharge time.

K TABLE		
TABLE 13.1		
Initial Temperature		Factor K
(°C)	(°F)	
16.7	62	1.098
17.2	63	1.092
17.8	64	1.086
18.3	65	1.080
18.9	66	1.072
19.4	67	1.064
20.0	68	1.056
20.6	69	1.048
21.1	70	1.040
21.7	71	1.034
22.2	72	1.029
22.8	73	1.023
23.4	74	1.017
23.9	75	1.011
24.5	76	1.006
25.0	77	1.000
25.6	78	0.994
26.1	79	0.987
26.7	80	0.980
27.2	81	0.976
27.8	82	0.972
28.3	83	0.968
28.9	84	0.964
29.4	85	0.960
30.0	86	0.956
30.6	87	0.952
31.1	88	0.948
31.6	89	0.944
32.2	90	0.940
32.8	91	0.938
33.4	92	0.936

APPENDIX

APPENDIX

HYDROGEN EVOLUTION CALCULATION

Significant amounts of hydrogen are evolved only as the battery approaches full charge. The maximum hydrogen evolution rate is 0.000267 cubic feet (7.56×10^{-6} cubic meters) per minute per charging ampere per cell at 77° F (25° C), one atmosphere.

To calculate the amount of hydrogen produced, consider an antimony alloy type (flat plate or tubular) battery at a point where it is nearing end of life, or equalize charge at 2.33 VPC.

Float Current demand of
fully charged stationary lead-acid cells.

Charge Voltage	Milliamperes per 100 Ah @ 8-hr. rate	
	Antimony	Calcium
	NEW-OLD	
2.15 vpc	15 - 60	—
2.17 vpc	19 - 80	4
2.20 vpc	26 - 105	6
2.23 vpc	37 - 150	8
2.25 vpc	45 - 185	11
2.27 vpc	60 - 230	12
2.33 vpc	120 - 450	24
2.37 vpc	195 - 700	38
2.41 vpc	300 - 1100	58

NOTE: The above values apply when the electrolyte temperature is 77° F (25° C). The values will double for every 15° F (8° C) of temperature rise. If the temperature drops, the current value will be halved for every 15° F (8° C) decrease. Antimony ranges indicate current increases due to cell aging.

HYDROGEN FORMULA

$$\text{Formula for hydrogen evolved—} C = \frac{FC}{1000} \times \frac{AH}{100} \times K \times N$$

C	=	Cubic feet (cubic meters) of hydrogen per minute
FC	=	Float current per 100 AH (temperature compensated) in milliamperes
AH	=	Ampere hours (nominal 8 hr.)
K	=	Constant—1 AH = 0.000267 cubic feet (7.56 x 10 ⁻⁶ cubic meters) per minute of hydrogen
N	=	Number of cells

EXAMPLE

60 cell GT-41 (3730 AH) near end of life, on equalize at 2.33 VPC at 92° F (33° C) electrolyte temperature

$$FC = 450 \text{ (from table)} \times 2 \text{ for } 92^\circ \text{ F (} 33^\circ \text{ C)} = 900 \text{ milliamperes}$$

$$C = \frac{900}{1000} \times \frac{3730}{100} \times 0.000267 \text{ cu. ft. (} 7.56 \times 10^{-6} \text{ cu. m.)} \times 60$$

$$\text{Hydrogen} = 0.538 \text{ cu. ft. (} 0.0152 \text{ cu. m.) per minute}$$

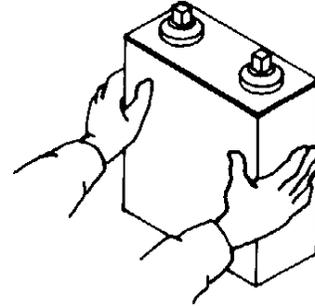
Assume a room size of 16,000 cu. ft. (452.5 cu. m.) that is allowed a 2% concentration of hydrogen or 320 cu. ft. (9.06 cu. m.). At the above hydrogen evolution rate of 0.538 cu. ft. (0.0152 cu. m.) per minute, it would require 10 hours to reach 2% concentration. Thus with one air change every 10 hours, the hydrogen concentration could be maintained below 2%.

PRECAUTIONS*

1. Do Not bring any heat or flame source near battery.
2. Do Not remove pressure relief valves.
3. Do Not use any lubricant other than EnerSys Pro-Slide or Dow Corning Silicon Compound #111 to lubricate rails to facilitate sliding of batteries.



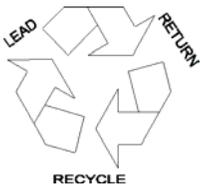
DO NOT PUSH ON CENTER
TO POSITION BATTERY



USE EDGE OF MODULE
WHEN POSITIONING BATTERY

4. Do Not lift any cells by the terminal posts.
5. Do Not tamper with seal nuts on the cell post.
6. Do Not remove lead coating from post or connectors and expose any bare copper.
7. Do Not allow cell temperature to exceed 110° F during charging.
8. Do Not clean cell with anything other than water/bicarbonate of soda.
9. Do Not over torque connections.
10. Do Not store EnerSys Lead Antimony batteries for over three months without charge – EnerSys Lead Calcium for over six months without charge, at normal temperatures.

* These are only a few of the precautions. Please read this manual thoroughly for complete details.



When ordering new batteries, also remember to properly recycle your old lead batteries. Federal and state regulations require lead-acid batteries be recycled. EnerSys' nationwide service organization can arrange pickup, transportation to and recycling at any one of our company affiliated smelters. Call 1-800-972-7372 for more information.



Please check our website for literature updates.



www.enersysinc.com

EnerSys Inc.
P.O. Box 14145
Reading, PA 19612-4145
USA
Tel: +1-610-208-1991
+1-800-538-3627

EnerSys EMEA
Brussels, Belgium
Tel: +32 (0)2 247 94 47
EnerSys Asia
Guangdong, China
Tel: +86 755 2689 3639

Represented by: