PowerSafe®

Battery Safety, Storage, Installation, Operation & Maintenance Manual

RE Flooded Lead-Acid Batteries

EnerSys®
Power/Full Solutions

RESERVE
POWER

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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, Warning, and Caution symbol 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, which 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 Charging Power Supply to the battery is off and that all power 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. Vented lead-acid (VLA) batteries can 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 and other items that may come in contact with the battery.
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® 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 mutilate the batteries. Released electrolyte is harmful to the eyes and skin and may also be toxic.

Warning

This unit contains flooded lead acid batteries. Lack of preventative maintenance could result in batteries exploding and emitting gasses and/or flame. Annual preventative maintenance must be performed per the guidelines set forth in this manual.

Warning

Failure to replace a battery before it becomes exhausted may cause the case to crack, possibly releasing electrolyte 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 of this unit must be done per the guidelines set forth in this manual. This is essential to the safety and reliability of your power supply system.

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1.0 GENERAL INFORMATION

1.1 Introduction

The EnerSys® range of PowerSafe® RE batteries has been designed for use in renewable energy applications. PowerSafe RE cells are designed for applications where the battery must undergo repeated cycling with daily depths of discharge ("DOD") of up to 80% DOD (such as rural settlements, communications systems and lighting systems, etc.). The RE range's abilities allow them to excel in highly demanding stored energy applications:

- **Long cycle life**
- **Overcharge ability**
- **Cycling in state of discharge**
- **Low rate of self-discharge**
- **Large electrolyte reserve**

1.1.1 Cell Design

PowerSafe RE cells are based on conventional, vented technology and designed for renewable energy applications that require maximum cycle life with the highest level of reliability. They are particularly suitable for use in solar energy installations, ensuring a continuity of electrical supply during the hours of darkness or during periods of reduced sunshine. The entire RE range utilizes tubular positive plates with EnerSys' proprietery tube technology. Tubular positive plates are widely used in batteries for particularly demanding applications. The current carrying lead metal in tubular designs are entirely surrounded by active material – reducing the corrosion rate and ensuring long life.

The RE range benefits from the square tubular plate when compared to both round tube and flat plate battery designs. The PowerSafe RE battery's square tubes provide more surface area on the positive plate, exposing more positive plate active material to the electrolyte. The unique tube construction also prevents shedding of the active material – a common failure mode in flat plate designs that can lead to early failure due to sediment shorts. This combination of greater positive surface area and reduced shedding allow for excellent cycling capacity.

Reduced maintenance is achieved through the use of additional electrolyte space above the element, which means cells may only have to be watered every 6 months depending on environmental conditions and duty cycle. Each cell is provided with a combination flame arrestor and float level indicator which clearly indicates when the electrolyte level is low and water must be added. The ample watering space and easily readable indicators help to reduce maintenance costs and makes them an ideal solution for many remote or unmanned locations.

1.1.2 Range Summary

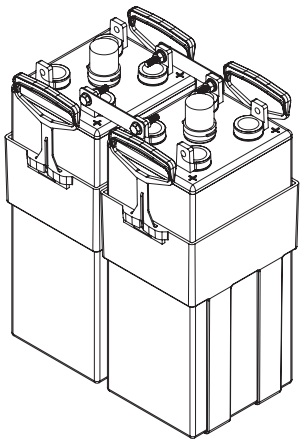
The range is available in single cell (2 Volt) units or 6 cell (12 Volt) units. All cells feature bolt-on connections at all terminals for ease of installation.

WARNING

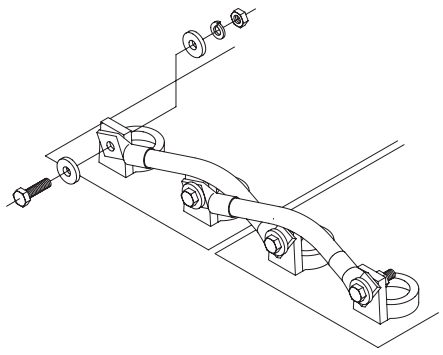
The RE series is intended for nominal system voltages up to **48 Volts. Exceeding this voltage is not recommended and can be extremely hazardous.** Contact your sales representive to inquire about custom designed batteries for high voltage applications.

The single cell units (1RE range) feature a rugged plastic container featuring lift handles. Sizes range from 207 Ah up to 2208 Ah at the 20 hour rate. They are ideal for remote locations where lifting equipment is not available for installation. The plastic container also reduces maintenance by helping mitigate ground shorts due to electrolyte spills. Any concern with container corrosion is also removed. The cells can be installed on any acceptable floor or on customer supplied racks.

The 6 cell units feature acid resistant epoxy-coated steel trays with lifting holes and mounting flanges to bolt the batteries to the floor or into a rack. Sizes range from 384 Ah up to 2208 Ah at the 20 hour rate. The 6 cell units are ideal for industrial applications where speed of installation and modular design is a high priority. Lifting can be done with an overhead crane using specially designed lifting straps available from EnerSys®. All intercell connections are made with welded lead connectors so only terminal connections must be made. Terminal connections of each unit are bolt-on, allowing easy cabling to the next unit or the DC bus.



SINGLE CELL (1RE)
Figure 1.1



6 – CELL (6RE)
Figure 1.2

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 Service.

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 Service.

2.0 SAFETY

2.1 General

All flooded, lead-acid 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® Service.

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

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.

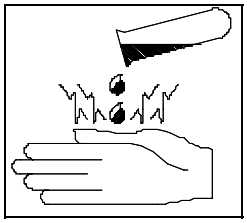
2.3 Safety Precautions

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**.

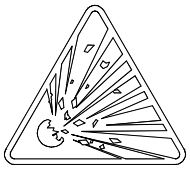
In case of sulfuric acid **CONTACT WITH CLOTHING OR MATERIAL, IMMEDIATELY**

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 regulation 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.

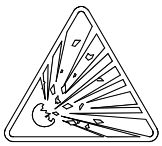
- **Always wear protective clothing and use nonconductive or insulated tools when working with ANY battery system.**
- **Remove all jewelry that could produce a short circuit.**

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, rack grounding is recommended.

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

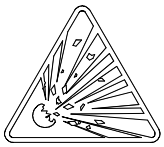
1. a shock hazard exists between all other terminals and ground (i.e., dirt and acid on top of battery cell touching rack).



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 terminals 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® Service.

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 precautions 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 1/2 inch (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 1/2 inch (12 mm) below the top of the plates, request an inspection by a representative of the carrier and file a claim for concealed damage.

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 Service.

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 the battery at a dry, clean and preferably cool and frost-free location. Temperature limits for storage are -20°C (-68 °F) to +45°C (113 °F), Humidity < 90% RH. Self discharge will occur when a battery is left at rest (without charge) and periodic freshening charge is required. Failure to charge batteries at the required intervals may result in irreversible damage.

Batteries that were previously in service or previously installed must be fully charged before storing for long periods of time.

Self discharge will increase:

- With natural aging of the cell
- Following faulty use such as excessive over-discharge, bad maintenance, or by the addition of non-demineralized water
- Temperature rise

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

4.2 Storage Interval

PowerSafe® RE batteries must be given a freshening charge at maximum storage times shown in the table below, or when open circuit voltage ("OCV") approaches 2.06 VPC, whichever occurs first. Under higher temperature conditions, greater charging frequency is required. Use date of battery shipment to determine freshening charge requirements.

TABLE 4.1	
Average storage Ambient temperature	**Maximum storage time**
20°C	6 months
25°C	5 months
30°C	4 months
40°C	2 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 freshening time interval is likely to be exceeded in storage, 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.

Make every effort to get the battery installed and 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. The diagrams shown are general representations and may not depict all models and options.

When planning the system space requirements for the PowerSafe® RE batteries, consider the following:

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

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

TABLE 5.1

CONSIDERATION	RECOMMENDATION
Space	It is recommended that the aisle space provided in front of all trays be a minimum of 36 inches (915 mm). The designer must verify the requirements for aisle space in all applicable local codes or regulations. A minimum of 9 inches (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. Each cell should be accessible for the addition of water and for taking individual cell voltage and hydrometer readings.
Environment	Clean, cool and dry. The location should be selected to keep water, oil, and dirt away from all cells.
Temperature	The recommended operating temperature range is between 5-113°F (-15°C - +45°C), Humidity >90%. Elevated temperatures reduce operating life. Lower temperatures reduce battery performance. Minimize temperature variations between the cells. • 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**
Ventilation	Adequate ventilation must be provided, so as to prevent hydrogen gas from exceeding a 2% concentration as shown in IEEE 484-1987. Hydrogen accumulation must be limited to less than 2% of the total volume of the battery area. Ventilation must be adequate to ensure that pockets of trapped hydrogen gas do not develop, particularly at the ceiling. See Appendix for additional information
Grounding	It is recommended that the steel trays be grounded in accordance with NEC and/or local codes.
Codes	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.
Floor	Reasonably level. Shim up to 1/4 inch (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.

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, as 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 inches/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 create no greater voltage drop than allowed 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,
- of equal lengths to the load (do not exceed cable ampacity), and
- of sufficient ampacity.

6.0 UNPACKING AND HANDLING FOR INSTALLATION

6.1 General

Batteries are shipped assembled, charged, and filled with the electrolyte.

All accessories for installation and use are supplied as optional prepackaged kits. Accessories may be in the same container as the cell, or separate containers depending on the item. 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)	
Drift Pins	
Floor Shims (User-supplied)	
Insulated 3/8 inch Drive Ratchet Wrench with Minimum 3" Extension With 3/8 inch thru 11/16 inch Sockets	
Insulated Box Wrenches (3/8 inch to 11/16 inch)	
Screwdrivers	
Wipes, Paper or Cloth	
Plastic Bristle Brush or Nonmetallic Cleaning Pad	
Tape Measure (Nonmetallic)	
Safety Equipment and Clothing	
Small Paint Brush	
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/Battery 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 two categories depending on the size of the units:

See Section 6.3.1 — single small cell handling (1RE)
See Section 6.3.2 — six cell unit handling (6RE)

DO NOT lift any cell by the terminal posts as this will **void the warranty**. RE cell terminals are not designed to support the cell weight. When lifting large cells/units with crane, hoist or similar device, use the lifting straps provided.

6.3.1 Single Small Cell Handling (1RE)

1. Lift and move these batteries manually. For cells heavier than 50 lbs, 2 people should be used to move and position cells.

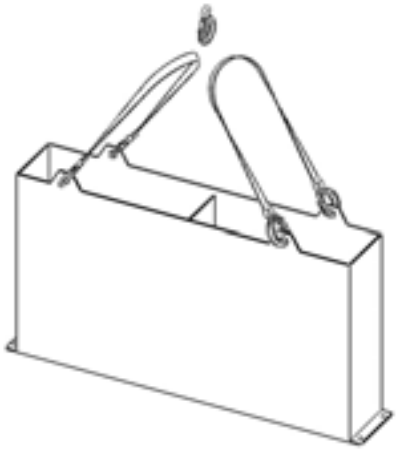
2. Optionally, a strap can be placed under the container and run through the handles for lifting with a crane. Contact your EnerSys sales/service representative for correct lifting strap and lifting instructions.

6.3.2 Six Cell Unit Handling (6RE)

When lifting 6 cells units in steel trays, use the supplied lifting straps with steel hooks to lift the unit by the eyelets at the top of the steel tray.

1. For sizes with 2 lifting eyes, use one strap.

2. For sizes with 4 lifting eyes, use two straps. Connect each strap to eyelets at each end of the battery. Put both straps through the crane hook for lifting.



Multicell Lifting
Figure 6.1

7.0 SYSTEM INSTALLATION

7.1 System Layout

Lay out the battery system before installation. Consult Section 5.0 for installation considerations.

1. Locate the system position in the area designated as determined in Section 5.0.

2. Mark the floor with system outline dimensions.

3. The floor must be level. Shimming up to 1/4 inch (6 mm) may be required to have the Battery System fully level.

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

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/Battery Handling.”

7.2 Installation Considerations

7.2.1 Installation Precautions

1. Install the system in a well-ventilated location; allow at least 4 inches (10 cm) 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, or any other 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 Service.

7.2.2 Arrangement

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

Take care when positioning cells to ensure that main battery terminals are not close together.

7.2.3 Spacing

Maintain proper spacing between cells/batteries to provide thermal management and ensure proper fit of hardware connections. Position cells/jars such that a ¼ inch (6mm) is maintained between adjoining units.

7.3 Battery Installation

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

1. Clear area where battery will be placed, allow space for installation maneuvering.
2. Employ the appropriate lifting/handling method for the cells to be installed (as described in Section 6.3).

   Exercise extreme caution when initially lifting cells and when lowering them into final position. 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.

3. After placement, carefully remove the lifting strap (if used) from the hook and pull the belt from under the module.

WARNING

Do not allow steel crane parts or steel hooks of lifting straps to come into contact with cell posts at any time. Allowing steel lifting parts to contact cell terminals may results in a short.

WARNING

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

WARNING

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

4. Lift the next cell/battery to be installed and place it next to the previously installed unit. See Figure 7.1. Be certain to allow proper spacing between cells/jars as outlined in Section 7.2.2. Observe proper polarity orientation.

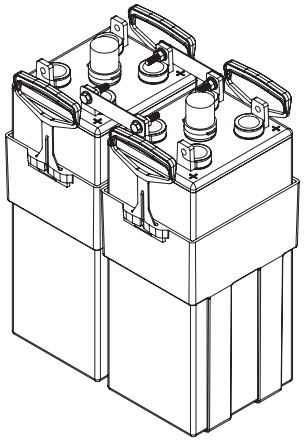
5. Repeat Procedures 5 thru 7 until all units are installed. See Figure 7.2.

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

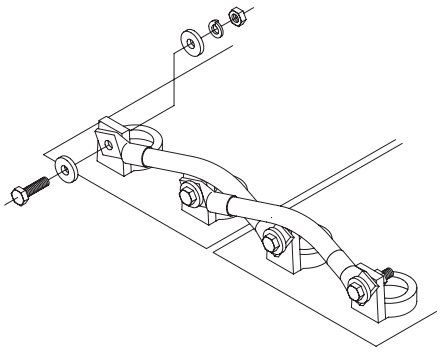
6. As soon as cells are unpacked and installed in position, remove the shipping vent plugs and immediately install the flame arrestors. DO NOT attempt to charge cells unless flame arrestors are in place.

   Once installed, DO NOT REMOVE the flame arrestors. They are provided with a filling funnel for adding water. Add water to the cells immediately after the indicator falls to the low level. 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.

7. Number the cells starting from the positive terminal of the battery for maintenance purposes. Pressure-sensitive adhesive labels are available from EnerSys®. Before applying the cell numbers, clean surfaces according to Procedure 3 in Section 12.1.1.



SINGLE CELL (1RE) CONNECTIONS
Figure 7.1



MULTI CELL UNITS (6RE) CONNECTIONS
Figure 7.2

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. 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.
2. Clean the contact surface with a stiff-bristle nonmetallic brush/pad until a clean, bright surface is obtained.
3. Apply a light coat of NO-OX-ID grease.

7.4.2 Intercell Connectors

1. The connections are made by bolting the supplied connectors/cable assemblies to the cell posts of opposite polarity on adjacent cells or batteries. When more than one cable for each cell is furnished, bolt the cable to the posts in the identical position on each battery.
2. With a small paintbrush, apply a light coat of heated NO-OX-ID grease to the contact surface of the terminal post.
3. Place cable lug directly on lead terminal surface. Use supplied ¼-20 bolts and washers to fasten cable to terminals. Secure all connections finger-tight to allow for some adjustment of position.
4. After all connections are completed, torque all stainless steel connector bolts to 70-75 inch-lbs (8.0-8.5 Nm).
5. 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. Ensure the entire cable lug and stainless steel bolt are coated.

WARNING

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.

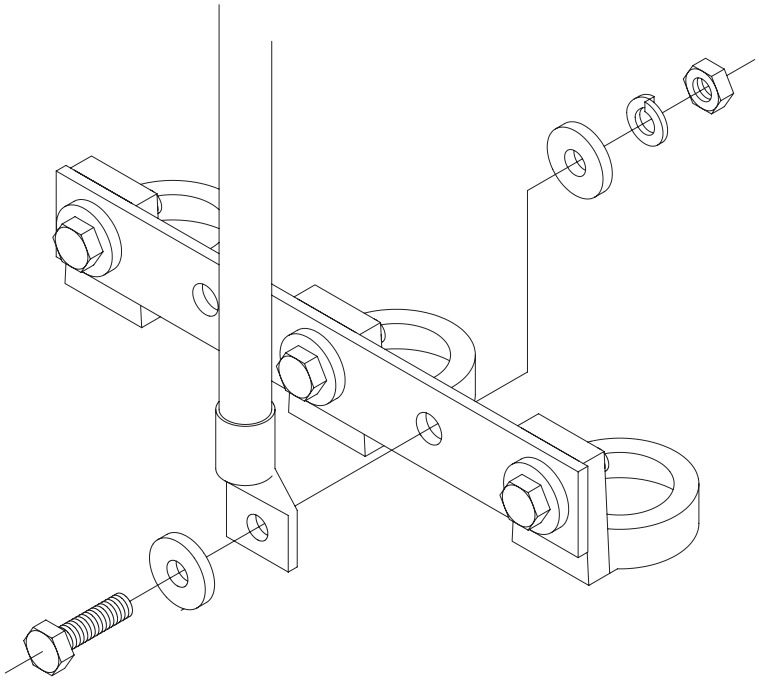
7.4.3 Terminal Plates

Terminal plates can be supplied as an option with the battery system to provide a system connection point (except for 2 post cells).

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 plating with excessive brushing.

2. With a small paintbrush, apply a light coating of heated NO-OX-ID grease to contact areas.

3. With a small paintbrush, apply a light coat of heated NO-OX-ID grease to the electrical contact areas of the terminal plate.



TERMINAL PLATE INSTALLATION
Figure 7.3

4. Install the terminal plate to the terminal connectors using the torque values of 70-75 inch-lbs (8.0-8.5 Nm).

5. Connect the positive lead from the charge controller to the positive terminal plate of the battery and the negative lead from the charge controller to the negative terminal plate of the battery.

6. 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.

7. Before activating the system:

    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 2.10 times the number of cells in the string.

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 or controller, ensure that shipping vent plugs are removed and flame arrestors are installed.

Initial charge is extremely important as it will condition the battery service life. So the battery must be fully recharged to ensure that it is in an optimum state of charge. Initial charge conditions depend on the type of equipment available per below:

8.1 External constant voltage charger or MPPT (Maximum Power Point Tracking) solar charge controller:

1. Charge at a constant voltage of 2.40 VPC at 77°F, corrected for temperature, for a minimum of 48hrs. Current should be limited to $0.14C_{20}$.

2. End-of-charge is when all cell voltages and electrolyte specific gravities (corrected to 25°C) cease to rise for three consecutive hourly readings. Continue charging until the specific gravity of electrolyte for all cells rise to nominal specific gravity at maximum level.

3. Add demineralized water if cells to not reach maximum level. Allow an additional 6 hours of charge for stirring of the electrolyte.

8.2 No external source or MPPT controller available for charging.

1. Connect the battery to the solar panel regulator and leave at rest for 1 to 2 weeks. For this charge, set the regulator to the following values:

TABLE 8.1

	Temp (°C)	Voltage
Low charge-restart voltage	0 to 20°C	2.30V
	20 to 40°C	2.30V
High charge-disconnect voltage	0 to 20°C	2.50V
	20 to 40°C	2.45V

2. Add demineralized water if cells to not reach maximum level. Allow an additional 3 days of charge for stirring of the electrolyte if water is added.

9.0 OPERATION

9.1 MPPT Charge Regulators

Recommended Inverter Settings:

Bulk (Absorb) Voltage: 2.40 VPC
Float Voltage: 2.25 VPC
Equalize Voltage: 2.67 VPC
Rebulk or Recharge Voltage: 2.08 VPC

Equalize charge should be done every 6 months for a minimum of 1 hour, maximum of 3 hours. If possible, add water during the last 30 minutes of equalize charge. This helps ensure good mixing of the electrolyte when the water is added.

9.1.1 ON/OFF Solar Charge Regulators

In order to ensure optimum recharge, the following setting charge disconnect and restart voltages can be applied:

TABLE 9.1				
TEMPERATURE				
	-20 to 0°C	**0 to 20°C**	**20 to 35°C**	**> 35°C**
Low charge-restart voltage (Vpc)	2.35V	2.30V	2.30V	2.25V
High charge-disconnect voltage (Vpc)	2.50V	2.45V	2.40V	2.35V

9.1.2 Low Voltage Disconnect

As a rule, installations will be equipped with a regulator whose voltage threshold values will protect against deep discharge:

TABLE 9.2			
DISCHARGE TIME			
	10h	**120h**	**240h**
Low voltage alarm	1.92V	1.92V	1.95V
Disconnect voltage	1.80V	1.85V	1.90V

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 in typical operation.

To take a specific gravity reading, use the level indicator's center funnel. Access this funnel flipping over the flame arrestor top.

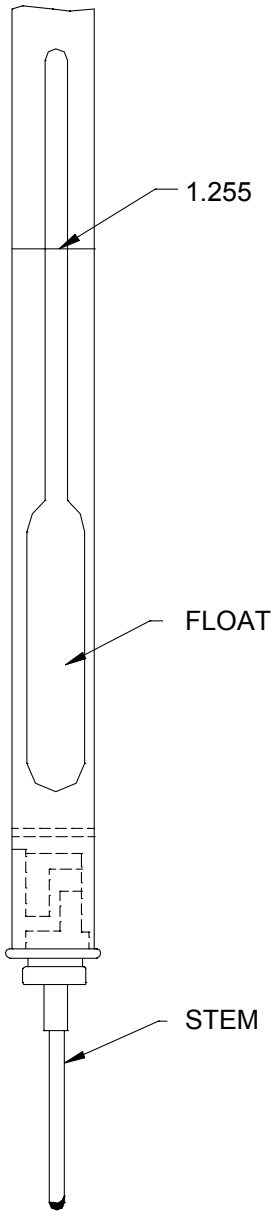
A long stemmed hydrometer can be purchased form EnerSys® for measurements (Cat. 81332). The long stem of the hydrometer can be cut down so it reaches the separator protector when the hydrometer is fully inserted.

9.3 Full-Charge Specific Gravity

With the cells fully charged and the electrolyte level ¼ from the bottom of the vent well (max level) the specific gravity of the electrolyte at 77° F (25° C) should read 1.255 ±.005. The full charge specific gravity will increase as water evaporates and the electrolyte level goes down.

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^{o} F (1.67^{o} C) of temperature above 77^{o} F (258^{o} C), add one point (.001) to the hydrometer reading. For every 3^{o} F (1.67^{o} C) of temperature below 77^{o} F (25^{o} C), subtract one point (.001) from the hydrometer reading.

9.4 Equalizing Charge

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:

- repeated deep discharge or idleness in a discharged state.
- failure to fully recharge the battery on a regular basis (partial state of charge operation).
- 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

MPPT Charge controllers use constant voltage charging as the method for giving an equalizing charge.

Use the voltage setting given in section 9.1 for correct equalize charge setting.

Equalize charge should be done every 6 months for a minimum of 1 hour, maximum of 3 hours. If possible, add water during the last 30 minutes of equalize charge. This helps ensure good mixing of the electrolyte when the water is added. Water tends to float on top of the electrolyte for awhile, but the gassing action of equalize charge will mix the water into the electrolyte.

Alternatively, if an outside charging source is available, the batteries may be constant current equalized at 4.5%, in amps, of the battery's nominal amp hour rating (C_{20}).

9.5 Operating Temperature

Under normal operating conditions, the battery lifetime largely depends on the temperature and depths of discharge. High temperature increases realized capacity but decreases life expectancy, while low temperatures decrease capacity, but may not affect life expectancy. See table below and chart below for expected life given by the two variables.

Daily Weighted Average Temperature	TABLE 9.3							
	DAILY DEPTH DISCHARGE @ C20							
	No. of Cycles	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**
	20	8891	4764	3164	2312	1852	1530	1319	1163
	25	8717	4671	3102	2266	1816	1500	1293	1140
	30	7514	4026	2674	1954	1566	1293	1115	983
	35	6478	3471	2305	1684	1350	1115	961	848
	40	5584	2992	1987	1452	1163	961	828	731
	45	4814	2580	1713	1252	1003	828	714	630

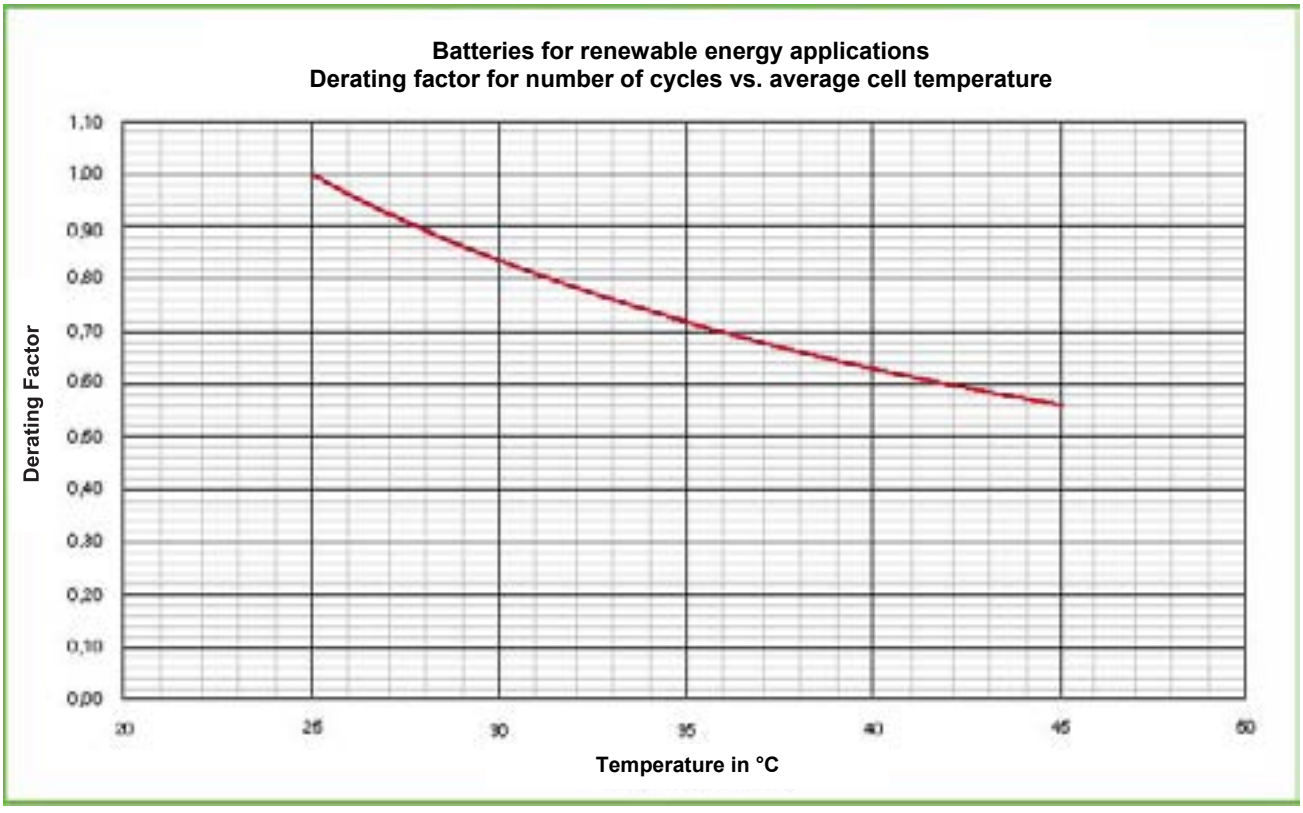


Figure 9.2

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. A cell near the middle of the battery layout is usually the best selection, as it will have the most representative temperature. This cell should be used for the charge controller temperature probe for voltage correction.

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

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. Unbolt and remove connectors.

2. Apply a solution of bicarbonate of soda and water to the cell posts and connectors/cable lugs to neutralize the corrosion (as described in Section 12.1.2, Procedure 2).

3. Clean the contact surfaces by rubbing the surface of the post or terminal and plated contact surfaces with a stiff-bristle nonmetallic brush/pad. **Exercise care so you do NOT remove the plating on the connectors, terminal plates or lugs, exposing copper.**

4. 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.

5. Reinstall and tighten connections to appropriate retorque value (see section 7.4). **DO NOT use any type of oil, solvent, detergent, petroleum-based solvent or ammonia solution to clean the jars or covers. These materials may cause permanent damage to the battery jar and cover and will void the warranty.**

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.

12.2 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® Service.

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^{o} F (25^{o} 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.

While specific gravity readings are a good indication of the health of a cell, other readings can be used to indicate relative health. However, it is highly recommended that a supplemental full set of readings on each cell (including specific gravity) be taken approximately two years after service initilization to verify that the floating conditions of the battery are appropriate.

The following schedule is recommended for good maintenance and records. Readings should be taken when battery is in float state of charge.

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

Annually

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

- Check all bolted connections to see if retorquing is required. Tighten all bolted connections to specifiications given in section 7.4.
- Check integrity of rack, if applicable.

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. 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^{o} F (3^{o} C), from each other during an inspection, determine the cause and correct the problem.

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.

Only add water to the battery when the battery is at full state of charge or during equalize charge. In this condition the electrolyte should be brought up ¼" from the bottom of the vent well. Watering the battery when it is not fully charged may cause an overflow when the battery does reach a fully charged state.

In cold climate with unheated battery rooms, water should be added only when the battery temperature is 50^{o} F (10^{o} 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										
		VOLTS	AMPS			PILOT CELL	ROOM	CELL	VOLTS	HYD. RDG	VOLTS	HYD. RDG	VOLTS	HYD. RDG	VOLTS	HYD. RDG	VOLTS	HYD. RDG
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								2										
								3										
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Notes

Quarterly

ADDING WATER
(when required)

Add water after completing hydrometer readings.

Date Quantity

_____ _____ Qts.

Annually

Connector Bolts
Retorqued

Acceptance Test Results — Date

Performance Test Results — Date

APPENDIX

HYDROGEN EVOLUTION CALCULATION OF RE CELLS

Every battery gives of hydrogen and oxygen during recharge. Most of the gassing occurs after the 80% point has been reached. The concentration of the gasses is proportional to the current being delivered to the battery.

To calculate the hydrogen produced, use the following formula, and ventilate the area as required. Hydrogen must be ventilated in order to avoid an explosion. Hydrogen concentrations of 4% or greater will cause an explosion.

Cubic Feet per Minute (cfm) of Hydrogen = 0.000013 x (nominal Ah capacity) x (number of cells)

For example, an installation with 24 cells of 1RE85-21 would be:

0.000013 x (960 Ah) x (24 cells) = 0.30 cfm of Hydrogen

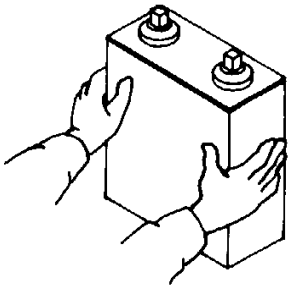
The National Fire Protection Association (NFPA) allows up to 1% concentration. Make sure the ventilation system can remove the hydrogen before it reaches concentrations of 1% within the battery area.

NOTE: The above values apply when the electrolyte temperature is 77^{o} F (25^{o} C). The cfm values will double for every 15^{o} F (8^{o} C) of temperature rise. If the temperature drops, the cfm values will be halved for every 15^{o} F (8^{o} C) decrease.

PRECAUTIONS*

1. Do Not bring any heat or flame source near battery.

DO NOT PUSH ON CENTER
TO POSITION BATTERY



USE EDGE OF MODULE
WHEN POSITIONING BATTERY

2. Do Not lift any cells by the terminal posts.

3. Do Not remove coating from post or connectors and expose any bare copper.

4. Do Not clean cell with anything other than water/bicarbonate of soda.

5. Do Not over torque connections.

6. Do Not exceed EnerSys recommended storage intervals without refreshing charge.

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

WARNING

Do Not use any lubricant other than EnerSys® Pro-Slide or Dow Corning Silicon Compound #111 to lubricate rails to facilitate sliding of batteries.

ISO 9000™

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