OPERATOR AND MAINTENANCE MANUAL FOR THE 24VDC EXPANDER PAK 1000

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GENERAL INFORMATION, THEORY OF OPERATION, AND EQUIPMENT DESCRIPTION

Energy Storage Modules - An Introduction

Energy storage modules (ESMs or “batteries”) serve as the foundation for every Hybrid Power System (HPS). When ESMs are employed in a power system, they can serve many different functions:

- Backup power for critical loads when the primary power source fails
- Power when periods of “silent” operation are critical
- Use of renewable power generation is desirable
- Less reliance on grid-utility power is desirable (peak shaving)

Energy storage is also critical to the HPS architecture. It enables the Inter-Connect System (and everything connected to it) to function.

There is a wide range of energy storage technologies, including small- and large-format lithium iron phosphate (LiFePO4) and lead-acid (Pb) batteries. ALL batteries are “consumable” parts of the HPS.

The role of a battery in a System is simply to discharge and recharge over time; this is known as“cycling”. Batteries are designed with a finite cycle-life expectancy, and several factors will determine just how many cycles a battery can endure before it is depleted:

1. Cell chemistry
2. Operational environments and conditions
3. Charging and discharging rates
4. Storage conditions (even though it may not be actively cycling, the chemical reaction in a battery never stops.)

All of these play roles in cycle-life expectancy, so selecting the best battery chemistry for a particular application is critical.

Formats and chemistries are selected based on the requirements of a particular application, but regardless of the battery type used in an HPS, there are two common attributes of all ESMs:

- Scalable—ESMs are scalable to meet System performance requirements.
- Modular—ESMs can be rotated, serviced, and/or swapped within the Inter-Connect network.

When assembling batteries or ESMs into an HPS for a particular application, the following need to be considered:

- Consistency of chemistry
- Consistency of operating voltage
- Proper cycling (depth of discharge and peak of recharge)
- Proper capacity for the intended load / application
- “One” battery bank (connected together, not disparately)

Important Product Safety Information and Instructions

This manual contains important safety instructions that must be followed during the installation and operation of this product. Read all instructions and safety information contained in this manual.

While this product is designed for indoor/outdoor operation, the user interface (control panels) must not be exposed to rain, snow, moisture, or liquids. Close and latch and/or lock the cases when the equipment is unattended.

Exercise caution when handling or operating equipment. Live power may be present.

Safety Information Labels

Your safety and the safety of others is very important.

Always read and obey all safety messages.

This is the safety alert symbol. This symbol alerts you to potential hazards that can kill you or hurt you and others. All safety messages will follow the safety alert symbol and the word “DANGER”, “WARNING”, or “CAUTION”. These words are defined as:

DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

All safety messages will tell you what the potential hazard is, tell you how to reduce the chance of injury, and tell you what can happen if the instructions are not followed.

Fire Hazard

Fire Types

Class A fire - Fires in ordinary combustibles such as wood, paper, cloth, trash, and plastics.

Class B fire - Fires in flammable liquids such as gasoline, petroleum, oil, and paint.

Class C fire - Fires involving energized electrical equipment such as motors, transformers, and appliances. Remove the power source and the class C fire becomes a class A or B fire.

Recommended Fire Extinguisher

NSN 4210-00-288-7219 Fire Extinguisher, Carbon Dioxide, 10 lb
Carbon dioxide is a liquefied gas, which is highly effective fighting class B and C fires. These extinguishers are ideal for areas where contamination and/or cleanup are a concern, such as data processing centers, labs, and telecommunication rooms.

⚠ WARNING

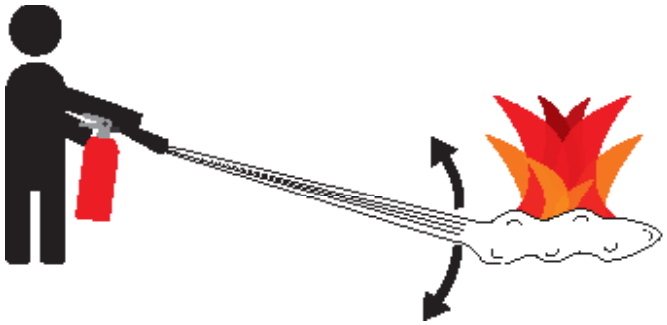
Only CO_2 (carbon dioxide) fire extinguishers should be used with this equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

Pull the pin.
Aim the nozzle or hose at the base of the fire from a safe distance.
Squeeze the operating lever to discharge the fire extinguishing agent.
Sweep the nozzle or hose from side to side until the fire is out. Move forward or around the fire as the fire diminishes.

Watch the area for reignition until the cause has been fixed.



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

- System components should not be operated in standing water.
- Close and latch the component lids if it is precipitating.
- System cables should not be routed through standing water.
- Cable connections should remain dry.
- Unused ports on System components should be covered when not in use to reduce the possibility of water intrusion.

Electric Shock Hazard

⚠ WARNING

Standing water around the electrical equipment and/or intrusion of water into the System components can increase the risk of electrical shock.

DON'T LET THIS BE YOU!

HIGH VOLTAGE: System components, photovoltaic (PV) arrays, and generators may produce lethal line voltages. Extreme care should be taken to protect against electrocution. Always work with another person in case an emergency occurs. Disconnect power before performing maintenance. Wear safety glasses whenever working on any part of a System that requires exposure to mechanical or direct electrical contacts.

⚠ WARNING

The Expander Pak is NOT GFCI protected.

Explosion Hazard

⚠ WARNING

DO NOT USE this product in an environment where flammable gases may be present, such as near propane tanks or enclosed containers where fuel, fumes, or hazardous chemicals are stored. Exercise great care to avoid arcing caused by a direct short circuit across DC terminals with a metal object.

Never make direct contact across a battery terminal posts with a conductive object. A direct short will cause burns, sparks, and possibly fire and/or explosion. Always disable the terminal posts at the master breaker when not in use.

Lead-acid Battery-operated Device

⚠ WARNING

Follow all instructions published by the battery manufacturer and manufacturer of the equipment in which the battery is installed. Make sure the area is well ventilated. Never smoke or allow sparks or flames near lead-acid batteries. Be careful not to drop a metal object onto the battery terminals or allow a metal tool to simultaneously touch the positive and the negative terminals of the battery. This could cause burns, sparks, fire, or explosion. Remove all personal items such as rings, bracelets, necklaces, and watches when working with lead-acid batteries. The battery produces a short circuit current high enough to weld a ring or other similar objects to metal, causing a severe burn.

If removing or rewiring a battery, be sure to remove the positive terminal first. To prevent an arc, make sure that there is no load on the battery by turning off all accessories before disconnecting. Always have someone within the range of the sound of your voice. Never work on a lead-acid battery alone.

Avoid direct contact with battery acid. Wear proper eye and skin protection. Be sure there is plenty of fresh water and soap nearby in case of clothing, skin, or eye contact with battery acid. If battery acid does contact clothing or skin, wash immediately with soap and water. If acid enters your eyes, flush immediately with running cold water for at least 20 minutes and get medical attention immediately.

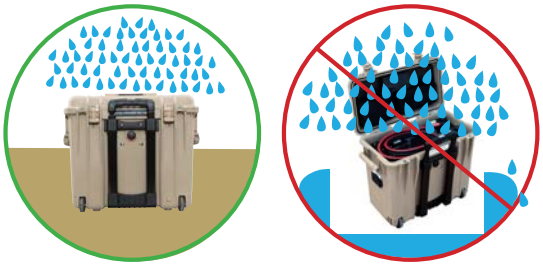
Keep a supply of baking soda on hand in the area of the batteries. Baking soda will neutralize the lead-acid battery electrolyte.

Environmental and Handling Precautions

The Expander Pak is ruggedized, yet there are a few things the operator can do to prevent failures and prolong the operational life.

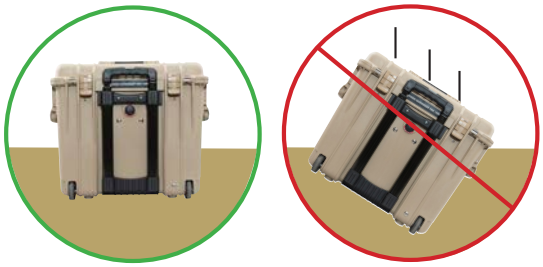
Water

If outdoor operation is necessary, the lid should be closed and latched whenever possible. **Lids should be open only to access operator controls and closed at all other times.**



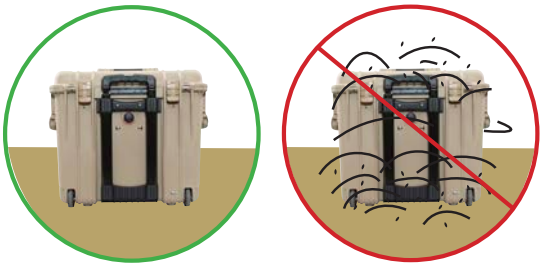
Impact

The Expander Pak should not be dropped onto hard surfaces at a height greater than one foot when transporting or during operation.



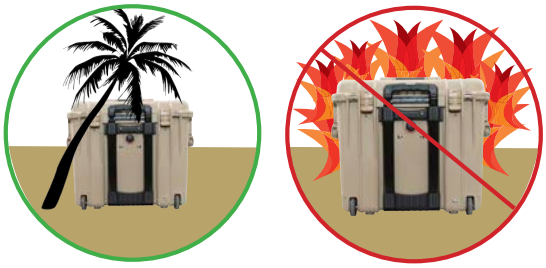
Dust

As a general rule, minimize exposure to high levels of particulates by exercising common-sense placement.



Heat

Heat and solar loading reduce efficiency and life expectancy. Shade the Expander Pak to prevent the negative effects of heat.



PRINCIPLES OF OPERATION – THE EXPANDER PAK

The Expander Pak is designed as a modular, scalable energy storage module (ESM) for service in any stand-alone power platform. Insertion of an Expander Pak into a circuit will allow the operator to "expand" the architecture and improve the operating efficiency of the entire network.

Expander Paks serve as the foundation for all hybrid power systems, and allow both renewables and traditional power sources to be used in concert.

The 24VDC Expander Pak 1000:

- 40 Ah (1.0 kWh) of energy storage capacity
- Advanced Lead-acid AGM chemistry
- High cycle life > 600 cycles (@80% depth of discharge)
- User interface
  - SOC indicator
  - 100-amp master breaker
  - DC Terminal Posts
  - Circuit Protections
- Ruggedized for extreme conditions
- MIL-STD-810G tested; GVT Safety Confirmation for worldwide deployment
- Field serviceable
- Transportable by land, sea, and air (passenger and cargo)
- Plug & Play connections

Adherence to operation and safety protocols will yield optimal performance from the Expander Pak for many years. Procedures for operation, preventive care, and maintenance are in this manual.

The Inter-Connect System

The System is comprised of three distinct types of technologies:

- Energy storage
- Power management
- Power generation

All of the individual components that operate in these categories utilize a unique connection architecture, know as the Inter-Connect Circuit.

The Inter-Connect Circuit is the skeletal backbone of the System's DC power network. It uses a simple, polarized, locking connection that is common throughout the architecture. All power management, energy storage, and power generation components are compatible with the Inter-Connect Circuit.

Using a common, polarized connector allows rapid "Plug & Play" scaling of components, adaptation of capabilities within the architecture, technology refreshment, and swapping of components when conditions warrant.

Communicating Voltage
All components on the Inter-Connect Circuit use one value to successfully operate in concert: battery voltage.

The Inter-Connect Circuit communicates battery voltage to all components on the network, allowing them to independently coordinate their respective functions. Voltage is used to trigger actions such as Automatic Generator Start/Stop (AGS) function, renewable power delegation, power distribution timing, and more.

The Importance of Proper Setup
While there is no unsafe way to make connections using a common polarized connector, proper setup of the Inter-Connect Circuit is critical in order to properly communicate voltage to all points in the System, ensuring all of the components operate together to provide seamless power.

Setup can also directly impact how power is metered in the network. Power management devices such as Power Hubs and PRO-Verters will meter current as it flows through the circuit, providing critical real-time data the operator can use to troubleshoot, verify system performance, and make programming/architectural changes based on evolving conditions. Consult the System Operator Manual for a connection schematic specific for a particular application.

Circuit Breaker Protections
The Inter-Connect network is protected from overloads and short circuits through a network of circuit breakers strategically placed throughout the circuit. It ensures the potential for a reverse polarity connection within the circuit is minimized. If a problem occurs in a leg of the Inter-Connect Circuit, the affected leg will disconnect from the primary network, leaving the other circuits functioning. If a major failure occurs in the circuit, then the entire network will shut down.

The Inter-Connect Plug

- Polarized
- 200 A maximum current
- 24 VDC connection only
- Mechanically “locks” into place
- Rotate knob clockwise to lock, counterclockwise to release
- Can be repaired or modified in the field

Figure 1. Inter-Connect Plug

Optimizing the Battery Configuration

A hybrid power system will function most efficiently when proper balance is achieved within the System's architecture (Energy Storage, Power Management, and Power Generation). The foundational component in the HPS architecture is the battery (Expander Pak). Generally, the amount of energy storage (battery capacity) required for any System will be directly proportional to the amount of load and power generation that is required for 1-2 battery cycles per day; however, two other system factors may also play a role in determining the necessary capacity:

- Application (external factors such as logistics and operation climate)
- Capabilities (internal factors such as system composition, including generation, AC/DC power management, distribution, etc)

Power Management Components that are connected to the battery bank must be able to pull and push enough current (amps) to/from the batteries to support their individual functions. This requires the establishment of a "minimum" capacity for proper system operation.

For example, PRO-Verters can require extremely high current (amperage) from the batteries when AC loads require power from the inverter, but it can also push high current into the battery when it is in charge mode.

Each Expander Pak has a built-in circuit breaker/cap that will limit the amount of current that is available from the individual batteries. In most System configurations where Expander Paks are used, the combined values of the Expander Pak circuit breakers must be greater than the rated demand of the connected power management/distribution equipment.

Connecting an insufficient number of Expander Paks (energy storage modules) than is needed will result in a situation where the following may occur:

- Circuit protections may unnecessarily engage
- Inaccurate voltage readings falsely trigger voltage-related functions in the system
- Battery health and overall life expectancy is degraded due to excessive cycling

Refer to the "Minimum Battery Capacity Recommendations" In the System Manuals or on relevant I-Plates to ensure trouble-free operation.

Determining Proper Battery Capacity for a System

Inherent to the HPS architecture is the ability to "scale" components to meet the System requirements, and a properly scaled battery bank is essential for successful operation of any HPS. Two general guidelines should be followed when scaling Expander Paks for proper capacity:

1. Power generated for a system must be equal to or greater than the total load requirement, so the battery bank must be able to store the requisite power.
2. A properly sized battery bank will cycle 1–2 times per day.

The "total load" in a 24-hour period can be used to baseline the energy storage capacity for a System. For example, if the total load requirement over 24 hours is 10 kWh, then the energy storage capacity can usually be scaled to that same metric.

Scaling Methods

“Plug & Play” architecture allows rapid expansion or contraction of battery capacity when conditions warrant.

Methods for scaling the energy storage capacity of an HPS are:

- ≤**10 kWh – “Daisy Chain” method**: Using the Inter-Connect port on the Expander Pak, it can be connected via Inter-Connect Cable to any other Expander Pak (of the same chemistry) that has multiple ports in a System
- ≥**10 kWh – “Parallel Connection” method**: Using Inter-Connect Strips and Cables, a “bank” of Expander Paks on a common bus network can be configured

Keys to Expander Pak Performance

- All Expander Paks should be connected into “one” common bank.
- All Expander Paks comprising a battery bank should be the same chemistry.
- All Expander Paks operating in a bank should be close in health (age, cycles, capacity).
- Follow initialization and calibration steps in System manuals when putting Expander Paks into service in a bank (system).
- Expander Paks prefer to be charged using a PRO-Verter or Power Hub. If any other charging device is used, it must be rated for the Expander Pak’s storage capacity, voltage, and current limit (see Alternative Charging Methods).
- Accurate monitoring (current, voltage, SOC, cycles, etc.) of a bank of Expander Paks should be obtained from the system’s PRO-Verter or Power Hub. **Note**: Information about an individual Expander Pak is not reported by the PRO-Verter or Power Hub; read Expander Pak voltage and SOC from the Expander Pak Faceplate.
- Fully charge Expander Paks before placing them into storage.

EQUIPMENT DESCRIPTION

The Expander Pak has the following features:

- 3’ DC accessory ring terminal cables
- 5’ Inter-Connect Cable
- 100-amp master circuit breaker switch
- 24-volt post terminals—internally mounted
- State of charge (SOC) display
- 24 VDC Inter-Connect ports

Figure 2. 24VDC Expander Pak 1000 and accessories

Case Interior

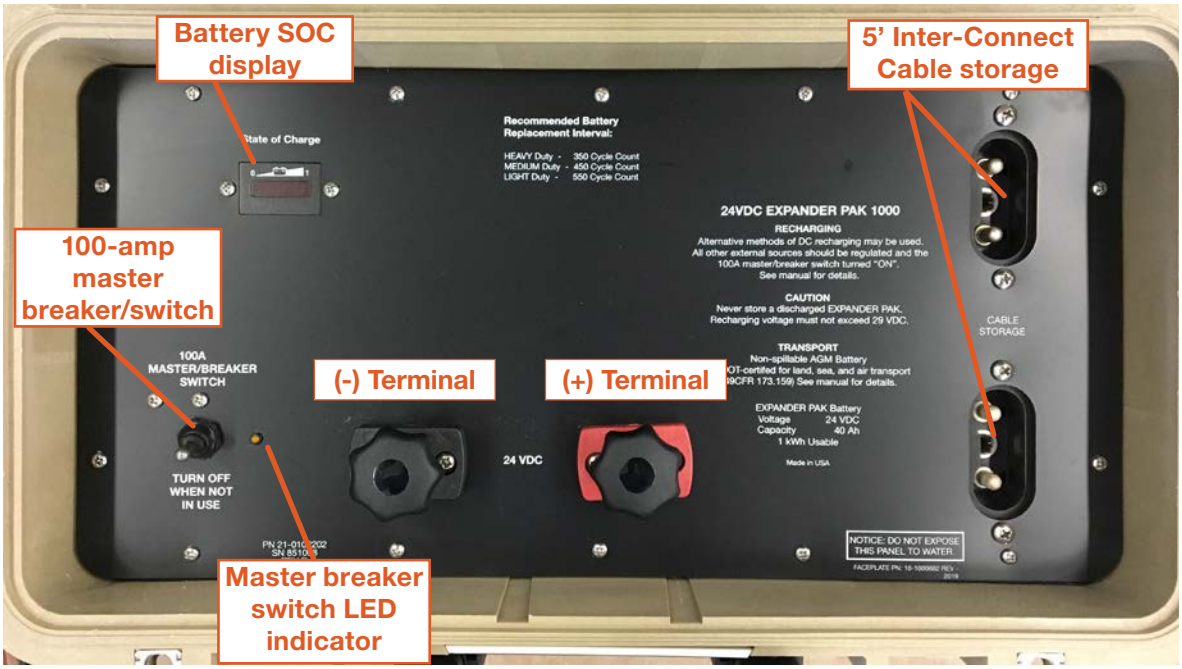


Figure 3. Expander Pak 1000 Faceplate

Figure 4. Expander Pak 1000 Inter-Connect cable storage

Case Exterior

Figure 5. Expander Pak 1000 exterior views and descriptions

OPERATOR INSTRUCTIONS

The 24VDC Expander Pak 1000 normal operating voltage ranges from 21.0 VDC to 29.0 VDC. Prior to operating the Expander Pak for the first time, charge it fully. Recharge it with connection to a PRO-Verter, Power Hub, or an external charging source such as a vehicle or other battery charger until the battery reaches float voltage. See Methods of Recharging the Expander Pak section.

Master Breaker Switch

The 100-amp master breaker switch connects the internal batteries to the terminal posts on the Expander Pak Faceplate and the two (2) Inter-Connect ports on each side of the Expander Pak.

The yellow LED on the Faceplate next to the breaker illuminates when the master breaker switch is turned on.

The master breaker switch MUST BE ON for batteries to be charged, or for power to be drawn out of the Expander Pak's batteries. However, power can flow through the Expander Pak from one Inter-Connect port to the other at any time.

Figure 6. 100 A master breaker switch and indicator LED

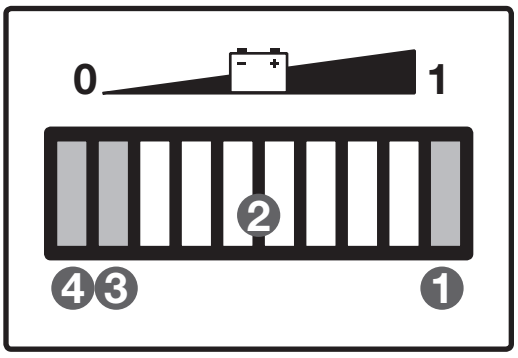
SOC Meter—Battery “Fuel Gauge”

The State of Charge (SOC) meter is active as long as the master breaker switch is turned on and there is sufficient charge in the Expander Pak batteries. It is only a general indication of the battery SOC, and is not a direct indication of the actual capacity of the battery.

Reading the Display

1. The right-most LED is lit only when the Expander Pak is charged fully (Figure 7, right).
2. As the Expander Pak SOC decreases, successive LEDs light up moving to the left, one on at a time (Figure 7, left).
3. The second-from-left LED flashes, indicating “BATTERY NEARLY DEAD” – 70% depth of discharge (Figure 7, left).
4. The two left-most LEDs alternately flash, indicating “DEAD BATTERY” – 80% depth of discharge (Figure 7, left).

Graphical key to all charge states



Fully Charged

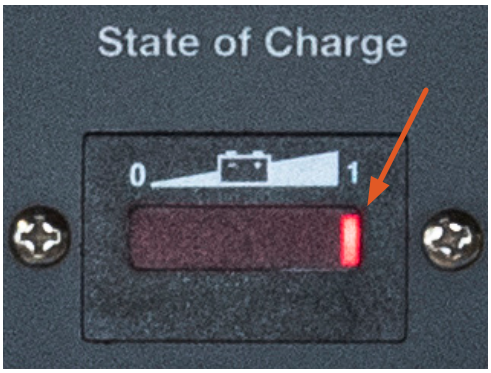


Figure 7. 24VDC Expander Pak 1000 SOC meter report

Note: Do not store a battery in a discharged state! This will compromise its life.

Alternative Methods of Recharging the Expander Pak

Alternative methods of recharging should be performed using only regulated charging sources appropriate for 24 VDC lead acid batteries. Methods include “jumping” from a vehicle system using traditional jumper cables, NATO to Inter-Connect Cable, or AC-to-battery charging device connected at the terminal posts.

The Expander Pak may remain active while charging connections are made. Once the charging device is connected, make sure the 100 A master breaker switch is turned on to recharge the Pak’s battery bank.

Figure 8. Recharging from a vehicle’s 24-volt system

Recharging Voltage

Do not connect an external charging source that exceeds 29.8 volts to the post terminals. This will damage the AGM battery bank and is not covered under any warranty.

Correct Polarity

Always connect to DC terminals using correct polarity. Failure to connect using correct polarity will trip the master breaker or trigger protection circuits to engage.

Expander Pak Transportation

Lifting the Expander Pak

The 24VDC Expander Pak 1000 requires a “two-man” lift. Do not attempt to lift the Expander Pak alone, as injury may occur. Use the wheels and transport handles whenever possible (Figure 10).

Figure 9. Two-man lift and weight

Figure 10. Dolly handle and wheels on Expander Pak

Transporting the Expander Pak

All Expander Paks are U.S. DOT-approved for land, sea, and air transport. (See Appendix B for full regulations.)

Before transporting an Expander Pak for a length of time greater than 48 hours, it is important to:

- Fully charge the Pak (Extended storage with battery voltage less than 24.2 volts will cause damage
- Turn off the master/breaker switch. If the master breaker switch is left on during transportation, it will drain the battery.
- **Never store a battery in a discharged state!**

MAINTENANCE INSTRUCTIONS

The function and efficiency of all electronic equipment is related to and dependent upon the temperature at which it is operating. It performs optimally within a narrow temperature range and less so as the temperature falls outside of that range. Heat will cause the Expander Pak performance to derate. Please use the following measures to mitigate against heat and other environmental effects:

- The Expander Pak should be shaded from direct sun exposure and sheltered from the elements as much as possible during operation.
- Expander Pak Faceplate should not ever be exposed to water or direct sunlight.
- Keep the Inter-Connect covers closed when not in use to prevent water and dust intrusion.
- Check the integrity of electrical connectors on a monthly basis.

Expander Pak Storage

There is a simple rule to remember about maintaining the Expander batteries:

> ***Never store an Expander Pak in a discharged state! Charge the Expander Pak fully before placing it in storage.***

Other than keeping the battery fully charged during storage, an AGM, or valve-regulated lead-acid (VRLA), type of battery does not require any type of maintenance by the operator (such as checking fluid levels).

The Expander Pak has a relatively low self-discharge rate at 77 ºF (25 ºC) and can be stored for up to one (1) year at this temperature before it needs to be recharged. However, the self-discharge rate increases as the storage temperature increases. See In-storage Preventive Maintenance Checks and Services for complete specific charging instructions for a particular Expander Pak battery chemistry.

Note: If the Expander Pak is stored at temperatures above 91 ºF (33 ºC), then the time between maintenance checks and / or charges must be reduced to three (3) months.

In-Storage Charging Procedures:

Charge one—charge all. It is important to maintain an equal level of health between all Expander Paks in a System. If one (1) Expander Pak in a System needs to be charged during storage, it is likely that any/all others will also need to be charged. Charging all of the Expander Paks until the they meet the criteria of being charged fully will maintain balance and equality among them.

In-storage Preventive Maintenance Checks and Services

Failure to follow these instructions may result in permanent equipment failure and/or personal injury.

Table 1. In-storage Preventive Maintenance Checks and Services

Item #	Item to be Inspected	Interval* at 91-140 ºF (33-60 ºC) Storage Temp	Interval* at 77-90 ºF (≤ 25-32 ºC) Storage Temp	Procedures	Non-mission Capable
1	Visual inspection of 24VDC Expander Pak 1000	M[1]	Q[2]	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior and ports. 3. Close all unused port covers.	~If the case is broken or split or if ports are damaged,the Expander Pak is NMC. Do not place into service.
2	SOC Meter (Figure 7)	M	Q	1. Turn on the master breaker switch. 2. Record the SOC in the maintenance/service log 3. If the SOC meter reports that the Expander Pak is not charged fully, proceed to Item #3.	~If either, or both of the two (2) left-most bars on the SOC meter are lit or flashing the Expander Pak is NMC.
3	In-storage maintenance charging	Q	S[3]	1. Charge Expander Pak. Follow the instructions for the battery charger used. 2. Charge until the Expander Pak is in float mode as reported by the battery charger and/or the right-most bar on the SOC meter.	~If the Expander Pak does not charge sufficiently after 48 hours, the Expander Pak is NMC .

[1]Monthly (M)—every month [2]Quarterly (Q)—every three months [3]Semiannually (S) – every 6 months

Cleaning the Interior Panel

Keep the user interface (interior panel surface) clean. Use a damp towel (no spray or dripping-wet cloths) to wipe the panel clean as necessary.

Water Intrusion—Prevention and Remediation

⚠ WARNING

Standing water around the electrical equipment or intrusion of water into the System components can increase the risk of electrical shock.

- The Expander Pak is weather resistant only when the lid is closed. If the case is left open during periods of rain or snow, water will accumulate in the case.
- If water intrusion is suspected, do not to try to move what may be a flooded component while it is still powered up. The electronics are mounted under the Faceplate and therefore are at the highest internal location. If water has intruded and splashes around inside the case during transport, damage to the sensitive electronics may occur.
- Remove the screw from the drain hole at the bottom edge of the component case. If water flows out of the drain hole after removal of the plug, let it flow until it stops. Then slightly and slowly tilt the case toward the drain hole to remove any remaining water. Continue to increase the angle of the component slowly until no more water drains from the hole. After the water has been drained, move the component to a safe dry location and remove the Faceplate. Place the component in the most dry environment possible for a time long enough that any remaining moisture inside will dry. When it is dry, reintegrate the component to the System and test it to determine if it is still functional.

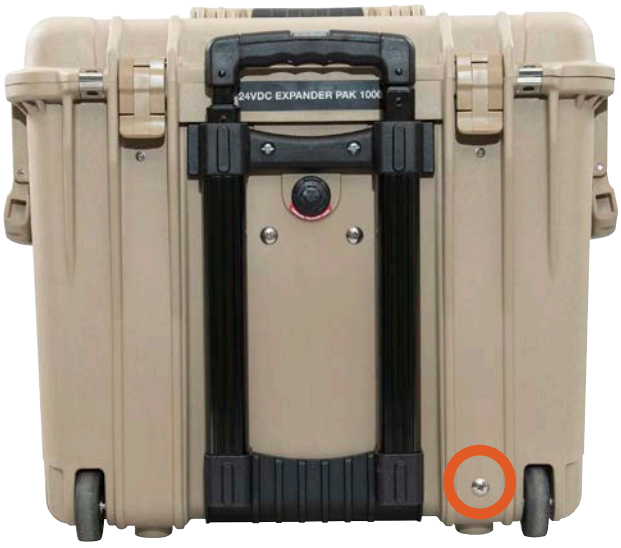


Figure 11. Drain plug screw

Disposal – Pb Battery

Lead-acid (Pb) batteries contain lead and are toxic. They should be disposed of properly or recycled in accordance with the Resource Conservation and Recovery Act. However, battery disposal regulations vary on national, state / provincial, and installation levels. Disposal must be conducted in accordance with all applicable regulations. ANY breached or leaking battery is managed as hazardous waste.

Before initiating the disposal or recycling process for the Pb Expander Pak, consult the local Hazardous Waste Storage Area (HWSA), Defense Reutilization and Marketing Office (DRMO), or other local authorities for the standard operating procedure for packaging, quantity, labeling, shipping, and tracking requirements. If an HWSA or DRMO is not available or does not accept the Pb Expander Pak, contact the servicing environmental compliance organization.

The Expander Pak contains recyclable materials, and recycling is encouraged over disposal if a battery recycling facility is available.

APPENDIX A
Lead-acid Battery Safety Data Sheet

Industrial Lead Acid Battery Safety Data Sheet

1. IDENTIFICATION ***REVISION DATE: 04-20-16***

Product Name: Lead Acid Battery, Non-Spillable Wet **Synonyms:** Industrial Battery, Traction Battery, Stationary Battery, Deep Cycle Battery	**Product Use**: Electric Storage Battery **Manufacturer/Supplier:** NorthStar Battery, Co., LLC **Address:** 4000 E. Continental Way, Springfield, MO 65803
General Information Number: 417.575.8200	**CAS Number:** Not Applicable **CHEMTREC: 800-424-9300**

2. GHS HAZARDS IDENTIFICATION

Health	Environmental	Physical
Acute Toxicity (Oral/Dermal/Inhalation) - Category 4 Skin Corrosion/Irritation - Category 1A Eye Damage - Category 1 Reproductive - Category 1A Carcinogenicity (lead) - Category 1B Carcinogenicity (arsenic) - Category 1A Carcinogenicity (acid mist) - Category 1A Specific Target Organ Toxicity (repeated exposure) - Category 2	Aquatic Chronic 1 Aquatic Acute 1	Explosive Chemical, Division 1.3

GHS Label:

Health	Environmental	Physical
		
Hazard Statements **DANGER!** Causes severe skin burns and eye damage. Causes serious eye damage. May damage fertility or the unborn child if ingested or inhaled. May cause cancer if ingested or inhaled. Causes damage to central nervous system, blood and kidneys through prolonged or repeated exposure. May form explosive air/gas mixture during charging. Extremely flammable gas (hydrogen). Explosive, fire, blast or projection hazard.	***Precautionary Statements*** Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Wear protective gloves/protective clothing, eye protection/face protection. Avoid breathing dust/fume/gas/mist/vapors/spray. Use only outdoors or in a well-ventilated area. Causes skin irritation, serious eye damage. Contact with internal components may cause irritation or severe burns. Avoid contact with internal acid. Irritating to eyes, respiratory system, and skin.	

Industrial Lead Acid Battery Safety Data Sheet

*3. *COMPOSITION / INFORMATION ON INGREDIENTS*

INGREDIENTS (Chemical/Common Names):	CAS No.:	% by Wt:
Lead and Lead Compounds (inorganic)	7439-92-1	**50**
Electrolyte (H2SO4/H2O)	7664-93-9	**17**
Lead Oxide	1309-60-0	**20**
Tin	7440-31-5	**0.2**

4. FIRST AID MEASURES

INHALATION:
Sulfuric Acid: Remove to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Consult a physician.
Lead: Remove from exposure, gargle, wash nose and lips; consult physician.

INGESTION:
Sulfuric Acid: Give large quantities of water; Do NOT induce vomiting or aspiration into the lungs may occur and can cause permanent injury or death; consult physician.
Lead: Consult physician immediately.

SKIN:
Sulfuric Acid: Flush with large amounts of water for at least 15 minutes; remove contaminated clothing completely, including shoes. If symptoms persist, seek medical attention. Wash contaminated clothing before reuse. Discard contaminated shoes.
Lead: Wash immediately with soap and water.

EYES:
Sulfuric Acid and Lead: Flush immediately with large amounts of water for at least 15 minutes while lifting lids; Seek immediate medical attention if eyes have been exposed directly to acid.

5. FIRE FIGHTING MEASURES

Flash Point: Not Applicable
Flammable Limits: LEL = 4.1% (Hydrogen Gas in air); UEL = 74.2%
Extinguishing media: CO2; foam; dry chemical. Do not use carbon dioxide directly on cells. Avoid breathing vapors. Use appropriate media for surrounding fire.

Fire Fighting Procedures:
Use positive pressure, self-contained breathing apparatus. Beware of acid splatter during water application and wear acid-resistant clothing, gloves, face and eye protection. If batteries are on charge, shut off power to the charging equipment, but note that strings of series connected batteries may still pose risk of electric shock even when charging equipment is shut down.

Hazardous Combustion Products:
Highly flammable hydrogen gas is generated during charging and operation of batteries. If ignited by burning cigarette, naked flame or spark, may cause battery explosion with dispersion of casing fragments and corrosive liquid electrolyte. Carefully follow manufacturer's instructions for installation and service. Keep away all sources of gas ignition and do not allow metallic articles to simultaneously contact the negative and positive terminals of a battery. Follow manufacturer's instructions for installation and service.

6: ACCIDENTAL RELEASE MEASURES
Stop flow of material, contain/absorb small spills with dry sand, earth or vermiculite. Do not use combustible materials. If possible, carefully neutralize spilled electrolyte with soda ash, sodium bicarbonate, lime, etc. Wear acid-resistant clothing, boots, gloves, and face shield. Do not allow discharge of un-neutralized acid to sewer. Acid must be managed in accordance with approved local, state, and federal requirements. Consult state environmental agency and/or federal EPA.

7. HANDLING AND STORAGE

Handling:
Unless involved in recycling operations, do not breach the casing or empty the contents of the battery. Handle carefully and avoid tipping, which may allow electrolyte leakage. There may be increasing risk of electric shock from strings of connected batteries. Keep containers tightly closed when not in use. If battery case is broken, avoid contact with internal components. Keep vent caps on and cover terminals to prevent short circuits. Place cardboard between layers of stacked automotive batteries to avoid damage and short circuits. Keep away from combustible materials, organic chemicals, reducing substances, metals, strong oxidizers and water. Use banding or stretch wrap to secure items for shipping.

Storage:
Store batteries under roof in cool, dry, well-ventilated areas separated from incompatible materials and from activities that may create flames, spark, or heat. Store on smooth, impervious surfaces provided with measures for liquid containment in the event of electrolyte spills. Keep away from metallic objects that could bridge the terminals on a battery and create a dangerous short-circuit.

Charging:
There is a possible risk of electric shock from charging equipment and from strings of series connected batteries, whether or not being charged. Shut-off power to chargers whenever not in use and before detachment of any circuit connections. Batteries being charged will generate and release flammable hydrogen gas. Charging space should be ventilated. Keep battery vent caps in position. Prohibit smoking and avoid creation of flames and sparks nearby. Wear face and eye protection when near batteries being charged.

Industrial Lead Acid Battery Safety Data Sheet

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limits (mg/m^3) **Note: N.E. = Not Established**

INGREDIENTS (Chemical/Common Names):	OSHA PEL	ACGIH	US NIOSH	Quebec PEV	Ontario OEL	EU OEL
Lead and Lead Compounds (inorganic)	0.05	0.05	0.05	0.05	0.05	0.15 (b)
Electrolyte (H_2SO_4/H_2O)	1	0.2	1	1	0.2	0.05 (c)
Tin	2	2	2			

(a) As dusts/mists **(b)** As inhalable aerosol **(c)** Thoracic fraction **(d)** Potential occupational carcinogen
(e) Based on OEL's of Austria, Belgium, Denmark, France, Netherlands, Switzerland, & U.K.
(f) Based on OEL of Belgium **(g)** Based on OEL of Netherlands

Engineering Controls (Ventilation):
Store and handle in well-ventilated area. If mechanical ventilation is used, components must be acid-resistant. Handle batteries cautiously, do not tip to avoid spills. Make certain vent caps are on securely. If battery case is damaged, avoid bodily contact with internal components. Wear protective clothing, eye and face protection, when filling, charging or handling batteries. Do not allow metallic materials to simultaneously contact both the positive and negative terminals of the batteries. Charge batteries in areas with adequate ventilation. General dilution ventilation is acceptable.

Respiratory Protection (NIOSH/MSHA approved):
None required under normal conditions. When concentrations of sulfuric acid mist are known to exceed PEL, use NIOSH or MSHA-approved respiratory protection.

Skin Protection:
If battery case is damaged, use rubber or plastic acid-resistant gloves with elbow-length gauntlet, acid-resistant apron, clothing and boots.
Eye Protection:
If battery case is damaged, use chemical goggles or face shield.

Other Protection:
In areas where water and sulfuric acid solutions are handled in concentrations greater than 1%, emergency eyewash stations and showers should be provided, with unlimited water supply. Chemically impervious apron and face shield recommended when adding water or electrolyte to batteries. Wash Hands after handling.

Industrial Lead Acid Battery Safety Data Sheet

9. PHYSICAL AND CHEMICAL PROPERTIES

Properties Listed Below are for Electrolyte:			
Boiling Point:	**203 - 240° F**		
Specific Gravity (H20 = 1)			
Silver Product	**1.320 +/- 0.01**		
Blue Product	**1.280 +/- 0.01**		
Red Product	**1.320 +/- 0.01**		
Blue +	**1.320 +/- 0.01**		
Boiling Point:	**203 – 204°F**		
Melting Point:	**N/A**	Vapor Pressure (mm Hg):	**10**
Solubility in Water:	**100%**	Vapor Density (AIR = 1):	**Greater than 1**
Evaporation Rate: (Butyl Acetate = 1)	**Less than 1**	% Volatile by Weight:	**N/A**
pH:	**~1 to 2**	Flash Point:	**Below room temperature (as hydrogen gas)**
LEL (Lower Explosive Limit)	**4% (Hydrogen)**	UEL (Upper Explosive Limit)	**74% (Hydrogen)**
Appearance and Odor:	**Manufactured article; no apparent odor. Electrolyte is a clear liquid with a sharp, penetrating, pungent odor.**		

10. STABILITY AND REACTIVITY

Stability: Stable _X_ Unstable ___
This product is stable under normal conditions at ambient temperature.

Conditions to Avoid: Prolonged overcharge at high current; sources of ignition.

Incompatibilities: (materials to avoid)
Electrolyte: Contact with combustibles and organic materials may cause fire and explosion. Also reacts violently with strong reducing agents, metals, sulfur trioxide gas, strong oxidizers, and water. Contact with metals may produce toxic sulfur dioxide fumes and may release flammable hydrogen gas.
Lead compounds: Avoid contact with strong acids, bases, halides, halogenates, potassium nitrate, permanganate, peroxides, nascent hydrogen, and reducing agents.

Hazardous Decomposition Products:
Electrolyte: Sulfur trioxide, carbon monoxide, sulfuric acid mist, sulfur dioxide, hydrogen sulfide.
Lead compounds: Temperatures above the melting point are likely to produce toxic metal fume, vapor, or dust; contact with strong acid or base or presence of nascent hydrogen may generate highly toxic arsine gas.

Hazardous Polymerization:
Will not occur

Industrial Lead Acid Battery Safety Data Sheet

11. TOXICOLOGICAL INFORMATION

Routes of Entry:
Sulfuric Acid: Harmful by all routes of entry.
Lead Compounds: Hazardous exposure can occur only when product is heated, oxidized or otherwise processed or damaged to create dust, vapor or fume. The presence of nascent hydrogen may generate highly toxic arsine gas.

Inhalation:
Sulfuric Acid: Breathing of sulfuric acid vapors or mists may cause severe respiratory irritation.
Lead Compounds: Inhalation of lead dust or fumes may cause irritation of upper respiratory tract and lungs.

Ingestion:
Sulfuric Acid: May cause severe irritation of mouth, throat, esophagus and stomach.
Lead Compounds: Acute ingestion may cause abdominal pain, nausea, vomiting, diarrhea and severe cramping. This may lead rapidly to systemic toxicity and must be treated by a physician.

Skin Contact:
Sulfuric Acid: Severe irritation, burns and ulceration.
Lead Compounds: Not absorbed through the skin.

Eye Contact:
Sulfuric Acid: Severe irritation, burns, cornea damage, and blindness.
Lead Compounds: May cause eye irritation.

Effects of Overexposure - Acute:
Sulfuric Acid: Severe skin irritation, damage to cornea, upper respiratory irritation.
Lead Compounds: Symptoms of toxicity include headache, fatigue, abdominal pain, loss of appetite, muscular aches and weakness, sleep disturbances and irritability.

Effects of Overexposure - Chronic:
Sulfuric Acid: Possible erosion of tooth enamel, inflammation of nose, throat & bronchial tubes.
Lead Compounds: Anemia; neuropathy, particularly of the motor nerves, with wrist drop; kidney damage; reproductive changes in males and females. Repeated exposure to lead and lead compounds in the workplace may result in nervous system toxicity. Some toxicologists report abnormal conduction velocities in persons with blood lead levels of 50 µg/100 ml or higher. Heavy lead exposure may result in central nervous system damage, encephalopathy and damage to the blood-forming (hematopoietic) tissues.

Industrial Lead Acid Battery Safety Data Sheet

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

Lead Compounds: Lead is listed as a 2B carcinogen, likely in animals at extreme doses. Proof of carcinogenicity in humans is lacking at present.

Medical Conditions Generally Aggravated by Exposure:
Overexposure to sulfuric acid mist may cause lung damage and aggravate pulmonary conditions. Contact of sulfuric acid with skin may aggravate diseases such as eczema and contact dermatitis. Lead and its compounds can aggravate some forms of kidney, liver and neurologic diseases.

Acute Toxicity:

Inhalation LD50:
Electrolyte: LC50 rat: 375 mg/m3; LC50: guinea pig: 510 mg/m3
Elemental Lead: Acute Toxicity Point Estimate = 4500 ppmV (based on lead bullion)

Oral LD50:
Electrolyte: rat: 2140 mg/kg
Elemental lead: Acute Toxicity Estimate (ATE) = 500 mg/kg body weight (based on lead bullion)

Additional Health Data:
All heavy metals, including the hazardous ingredients in this product, are taken into the body primarily by inhalation and ingestion. Most inhalation problems can be avoided by adequate precautions such as ventilation and respiratory protection covered in Section 8. Follow good personal hygiene to avoid inhalation and ingestion: wash hands, face, neck and arms thoroughly before eating, smoking or leaving the work site. Keep contaminated clothing out of non-contaminated areas, or wear cover clothing when in such areas. Restrict the use and presence of food, tobacco and cosmetics to non-contaminated areas. Work clothes and work equipment used in contaminated areas must remain in designated areas and never taken home or laundered with personal non-contaminated clothing. This product is intended for industrial use only and should be isolated from children and their environment.

The 19th Amendment to EC Directive 67/548/EEC classified lead compounds, but not lead in metal form, as possibly toxic to reproduction. Risk phrase 61: May cause harm to the unborn child, applies to lead compounds, especially soluble forms.

Industrial Lead Acid Battery Safety Data Sheet

12. ECOLOGICAL INFORMATION

Environmental Fate: lead is very persistent in soil and sediments. No data on environmental degradation. Mobility of metallic lead between ecological compartments is slow. Bioaccumulation of lead occurs in aquatic and terrestrial animals and plants but little bioaccumulation occurs through the food chain. Most studies include lead compounds and not elemental lead.

Environmental Toxicity: Aquatic Toxicity:
Sulfuric acid: 24-hr LC50, freshwater fish (Brachydanio rerio): 82 mg/L
96-hr LOEC, freshwater fish (Cyprinus carpio): 22 mg/L
Lead: 48-hr LC50 (modeled for aquatic invertebrates): <1 mg/L, based on lead bullion

Additional Information
· No known effects on stratospheric ozone depletion.
· Volatile organic compounds: 0% (by Volume)
· Water Endangering Class (WGK): NA

13. DISPOSAL CONSIDERATIONS (UNITED STATES)

Spent batteries: Send to secondary lead smelter for recycling. Spent lead-acid batteries are not regulated as hazardous waste when the requirements of 40 CFR Section 266.80 are met. Spilled sulfuric acid is a characteristic hazardous waste; EPA hazardous waste number D002 (corrosivity) and D008 (lead).

Electrolyte: Place neutralized slurry into sealed acid resistant containers and dispose of as hazardous waste, as applicable. Large water diluted spills, after neutralization and testing, should be managed in accordance with approved local, state, and federal requirements. Consult state environmental agency and/or federal EPA.

Following local, State/Provincial, and Federal/National regulations applicable to end-of-life characteristics will be the responsibility of the end-user.

14. TRANSPORT INFORMATION

U.S.DOT – (Land Transport):
Excepted from the hazardous materials regulations (HMR) because the batteries meet the requirements of 49 CFR 173.159(f) and 49 CFR 173.159a of the U.S. Department of Transportation's HMR. Battery and outer package must be marked "NONSPILLABLE" or "NONSPILLABLE BATTERY". Battery terminals must be protected against short circuits.

IATA Dangerous Goods Regulations DGR (Air Transport): Excepted from the dangerous goods regulations because the batteries meet the requirement of Packing Instruction 872 and Special Provisions A67 of the International Air Transportation Association (IATA) Dangerous goods Regulations and International Civil Aviation Organization (ICAO) Technical Instruction. Battery Terminals must be protected against short circuits. The words “NOT RESTRICTED”, “SPECIAL PROVISION A67” must be provided when the air waybill is issued.
IMDG (Sea Transport): Excepted from the dangerous goods regulations for transport by sea because the batteries meet the requirements of Special Provision 238 of the International Maritime Dangerous Goods (IMDG CODE). Battery terminals must be protected against short circuits.

15. REGULATORY INFORMATION

UNITED STATES:

EPA SARA Title III:
Section 302 EPCRA Extremely Hazardous Substances (EHS):
Sulfuric acid is a listed "Extremely Hazardous Substance" under EPCRA, with a Threshold Planning Quantity (TPQ) of 1,000 lbs. EPCRA Section 302 notification is required if 500 lbs or more of sulfuric acid is present at one site (40 CFR 370.10). For more information consult 40 CFR Part 355.

Section 304 CERCLA Hazardous Substances:
Reportable Quantity (RQ) for spilled 100% sulfuric acid under CERCLA (Superfund) and EPCRA (Emergency Planning and Community Right to Know Act) is 1,000 lbs. State and local reportable quantities for spilled sulfuric acid may vary.

Section 311/312 Hazard Categorization:
EPCRA Section 312 Tier Two reporting is required for non-automotive batteries if sulfuric acid is present in quantities of 500 lbs or more and/or if lead is present in quantities of 10,000 lbs or more. For more information consult 40 CFR 370.10 and 40 CFR 370.40

Section 313 EPCRA Toxic Substances: 40 CFR section 372.38 (b) states: If a toxic chemical is present in an article at a covered facility, a person is not required to consider the quantity of the toxic chemical present in such article when determining whether an applicable threshold has been met under § 372.25, § 372.27, or § 372.28 or determining the amount of release to be reported under § 372.30. This exemption applies whether the person received the article from another person or the person produced the article. However, this exemption applies only to the quantity of the toxic chemical present in the article.

Industrial Lead Acid Battery Safety Data Sheet

Supplier Notification: This product contains toxic chemicals that may be reportable under EPCRA Section 313 Toxic Chemical Release Inventory (Form R) requirements. For a manufacturing facility under SIC codes 20 through 39, the following information is provided to enable you to complete the required reports:

Toxic Chemical	CAS Number	Approximate % by Weight
Lead	7439-92-1	50
Sulfuric Acid/Water Solution	7664-93-9	17
Lead Oxide	1360-60-0	20
Tin	7440-31-5	0.2

See 40 CFR Part 370 for more details.

TSCA:
TSCA Section 8b – Inventory Status: All chemicals comprising this product are either exempt or listed on the TSCA Inventory.

TSCA Section 12b (40 CFR Part 707.60(b)) No notice of export will be required for articles, except PCB articles, unless the Agency so requires in the context of individual section 5, 6, or 7 actions.

TSCA Section 13 (40 CFR Part 707.20): No import certification required (EPA 305-B-99-001, June 1999, Introduction to the Chemical Import Requirements of the Toxic Substances Control Act, Section IV.A)

RCRA: Spent Lead Acid Batteries are subject to streamlined handling requirements when managed in compliance with 40 CFR section 266.80 or 40 CFR part 273. Waste sulfuric acid is a characteristic hazardous waste; EPA hazardous waste number D002 (corrosivity) and D008 (lead).

STATE REGULATIONS (US):
STATE REGULATIONS (US):
***Proposition 65 Warning**
Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm. Wash hands after handling.

*Battery companies not party to the 1999 consent judgment with Mateel Environmental Justice Foundation should include a Proposition 65 Warning that complies with the current version of Proposition 65.

INTERNATIONAL REGULATIONS:
Distribution into Quebec to follow Canadian Controlled Product Regulations (CPR) 24(1) and 24(2).

Distribution into the EU to follow applicable Directives to the Use, Import/Export of the product as-sold.

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16. OTHER INFORMATION

NFPA Hazard Rating for sulfuric acid:
Flammability (Red) = 0
Health (Blue) = 3
Reactivity (Yellow) = 2

Sulfuric acid is water-reactive if concentrated.

APPENDIX B

U.S. DOT Regulations for Transport of Expander Pak

CODE OF FEDERAL REGULATIONS

Title 49, Volume 2, Parts 100 to 185
Revised as of October 1, 1999

Cite: 49 CFR 173.159

Title 49: Transportation
PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS
Subpart E—Non-bulk Packaging for Hazardous Materials Other Than Class 1 and Class 7

§ 173.159 Batteries, wet.

(a) Electric storage batteries, containing electrolyte acid or alkaline corrosive battery fluid (wet batteries), may not be packed with other materials except as provided in paragraphs (g) and (h) of this section and in §§173.220 and 173.222; and any battery or battery-powered device must be prepared and packaged for transport in a manner to prevent:

(1) A dangerous evolution of heat (i.e., an amount of heat sufficient to be dangerous to packaging or personal safety to include charring of packaging, melting of packaging, scorching of packaging, or other evidence);

(2) Short circuits, including, but not limited to:

(i) Packaging each battery or each battery-powered device when practicable, in fully enclosed inner packagings made of non-conductive material;

(ii) Separating or packaging batteries and battery-powered devices in a manner to prevent contact with other batteries, devices or conductive materials (e.g., metal) in the packagings; or

(iii) Ensuring exposed terminals are protected with non-conductive caps, non-conductive tape, or by other appropriate means; and

(3) Damage to terminals. If not impact resistant, the outer packaging must not be used as the sole means of protecting the battery terminals from damage or short circuiting. Batteries must be securely cushioned and packed to prevent shifting which could loosen terminal caps or reorient the terminals. Batteries contained in devices must be securely installed. Terminal protection methods include but are not limited to:

(i) Securely attaching covers of sufficient strength to protect the terminals;

(ii) Packaging the battery in a rigid plastic packaging; or

(iii) Constructing the battery with terminals that are recessed or otherwise protected so that the terminals will not be subjected to damage if the package is dropped.

(b) For transportation by aircraft:

(1) The packaging for wet batteries must incorporate an acid- or alkali-

proof liner, or include a supplementary packaging with sufficient strength and adequately sealed to prevent leakage of electrolyte fluid in the event of spillage; and

(2) Any battery-powered device, equipment or vehicle must be packaged for transport in a manner to prevent unintentional activation or must have an independent means of preventing unintentional activation (e.g., packaging restricts access to activation switch, switch caps or locks, recessed switches, trigger locks, temperature sensitive circuit breakers, etc.).

(c) The following specification packagings are authorized for batteries packed without other materials provided all requirements of paragraph (a) of this section, and for transportation by aircraft, paragraph (b) of this section are met:

(1) Wooden box: 4C1, 4C2, 4D, or 4F.

(2) Fiberboard box: 4G.

(3) Plywood drum: 1D.

(4) Fiber drum: 1G.

(5) Plastic drum: 1H2.

(6) Plastic jerrican: 3H2.

(7) Plastic box: 4H2.

(d) The following non-specification packagings are authorized for batteries packed without other materials provided all requirements of paragraph (a) of this section, and for transportation by aircraft, paragraph (b) of this section are met:

(1) Electric storage batteries are firmly secured to skids or pallets capable of withstanding the shocks normally incident to transportation are authorized for transportation by rail, highway, or vessel. The height of the completed unit must not exceed 1 1/2 times the width of the skid or pallet. The unit must be capable of withstanding, without damage, a superimposed weight equal to two times the weight of the unit or, if the weight of the unit exceeds 907 kg (2,000 pounds), a superimposed weight of 1814 kg (4,000 pounds). Battery terminals must not be relied upon to support any part of the superimposed weight and must not short out if a conductive material is placed in direct contact with them.

(2) Electric storage batteries weighing 225 kg (500 pounds) or more, consisting of carriers' equipment, may be shipped by rail when mounted on suitable skids. Such shipments may not be offered in interchange service.

(3) One to three batteries not over 11.3 kg (25 pounds) each, packed in strong outer boxes. The maximum authorized gross weight is 34 kg (75 pounds).

(4) Not more than four batteries not over 7 kg (15 pounds) each, packed in strong outer fiberboard or wooden boxes. The maximum authorized gross weight is 30 kg (65 pounds).

(5) Not more than five batteries not over 4.5 kg (10 pounds) each, packed in strong outer fiberboard or wooden boxes. The maximum authorized gross weight is 30 kg (65 pounds).

(6) Single batteries not exceeding 34 kg (75 pounds) each, packed in 5-sided

slip covers or in completely closed fiberboard boxes. Slip covers and boxes must be of solid or double-faced corrugated fiberboard of at least 91 kg (200 pounds) Mullen test strength. The slip cover or fiberboard box must fit snugly and provide inside top clearance of at least 1.3 cm (0.5 inch) above battery terminals and filler caps with reinforcement in place. Assembled for shipment, the bottom edges of the slipcover must come to within 2.5 cm (1 inch) of the bottom of the battery. The completed package (battery and box or slip cover) must be capable of withstanding a top-to-bottom compression test of at least 225 kg (500 pounds) without damage to battery terminal caps, cell covers or filler caps.

(7) Single batteries exceeding 34 kg (75 pounds) each may be packed in completely closed fiberboard boxes. Boxes must be of double-wall corrugated fiberboard of at least 181 kg (400 pounds) test, or solid fiberboard testing at least 181 kg (400 pounds); a box may have hand holes in its ends provided that the hand holes will not materially weaken the box. Sides and ends of the box must have cushioning between the battery and walls of the box; combined thickness of cushioning material and walls of the box must not be less than 1.3 cm (0.5 inch); and cushioning must be excelsior pads, corrugated fiberboard, or other suitable cushioning material. The bottom of the battery must be protected by a minimum of one excelsior pad or by a double-wall corrugated fiberboard pad. The top of the battery must be protected by a wood frame, corrugated trays or scored sheets of corrugated fiberboard having minimum test of 91 kg (200 pounds), or other equally effective cushioning material. Top protection must bear evenly on connectors and/or edges of the battery cover to facilitate stacking of batteries. No more than one battery may be placed in one box. The maximum authorized gross weight is 91 kg (200 pounds).

(e) When transported by highway or rail, electric storage batteries containing electrolyte or corrosive battery fluid are not subject to any other requirements of this subchapter, if all of the following are met:

(1) No other hazardous materials may be transported in the same vehicle;

(2) The batteries must be loaded or braced so as to prevent damage and short circuits in transit;

(3) Any other material loaded in the same vehicle must be blocked, braced, or otherwise secured to prevent contact with or damage to the batteries; and

(4) The transport vehicle may not carry material shipped by any person other than the shipper of the batteries.

(f) Batteries can be considered as non-spillable provided they are capable of withstanding the following two tests, without leakage of battery fluid from the battery:

(1) Vibration test . The battery must be rigidly clamped to the platform of a vibration machine, and a simple harmonic motion having an amplitude of 0.8 mm (0.03 inches) with a 1.6 mm (0.063 inches) maximum total excursion must be applied. The frequency must be varied at the rate of 1 Hz/min between the limits of 10 Hz to 55 Hz. The entire

range of frequencies and return must be traversed in 95 ± 5 minutes for each mounting position (direction of vibrator) of the battery. The battery must be tested in three mutually perpendicular positions (to include testing with fill openings and vents, if any, in an inverted position) for equal time periods.

(2) Pressure differential test . Following the vibration test, the battery must be stored for six hours at 24 °C ± 4 °C (75 °F ± 7 °F) while subjected to a pressure differential of at least 88 kPa (13 psig). The battery must be tested in three mutually perpendicular positions (to include testing with fill openings and vents, if any, in an inverted position) for at least six hours in each position.

(g) Electrolyte, acid or alkaline corrosive battery fluid, packed with batteries wet or dry, must be packed in one of the following specification packagings:

(1) In 4C1, 4C2, 4D, or 4F wooden boxes with inner receptacles of glass, not over 4.0 L (1 gallon) each with not over 8.0 L (2 gallons) total in each outside container. Inside containers must be well-cushioned and separated from batteries by a strong solid wooden partition. The completed package must conform to Packing Group III requirements.

(2) Electrolyte, acid, or alkaline corrosive battery fluid included with electric storage batteries and filling kits may be packed in strong rigid outer packagings when shipments are made by, for, or to the Departments of the Army, Navy, or Air Force of the United States. Packagings must conform to military specifications. The electrolyte, acid, or alkaline corrosive battery fluid must be packed in polyethylene bottles of not over 1.0 L (0.3 gallon) capacity each. Not more than 24 bottles, securely separated from electric storage batteries and kits, may be offered for transportation or transported in each package.

(3) In 4G fiberboard boxes with not more than 12 inside packagings of polyethylene or other material resistant to the lading, each not over 2.0 L (0.5 gallon) capacity each. Completed packages must conform to Packing Group III requirements. Inner packagings must be adequately separated from the storage battery. The maximum authorized gross weight is 29 kg (64 pounds). These packages are not authorized for transportation by aircraft.

(h) Dry batteries or battery charger devices may be packaged in 4G fiberboard boxes with inner receptacles containing battery fluid. Completed packagings must conform to Packing Group III requirements. Not more than 12 inner receptacles may be packed in one outer box. The maximum authorized gross weight is 34 kg (75 pounds).

(i) When approved by the Associate Administrator, electric storage batteries, containing electrolyte or corrosive battery fluid in a separate reservoir from which fluid is injected into the battery cells by a power device cartridge assembled with the battery, and which meet the criteria of paragraph (f) are not subject to any other requirements of this subchapter.

[74 FR 2257, Jan. 14, 2009]