Battery Safety

To: To everyone who handles, prepares or offers batteries for transportation.

All batteries should be handled, packaged and stored in a manner that prevents short-circuits. When handled or packaged incorrectly, some batteries may short and are capable of creating an electrical circuit. This type of un-grounded circuit can generate heat sufficient to ignite surrounding plastic or paper packaging materials. Batteries with external terminals are more susceptible to shorts since the terminals can contact each other, metal banding used to secure batteries to pallets, metal drum walls or even the transport vehicle itself. Batteries should be insulated and/or otherwise stored in a manner that prevents the terminals from creating a circuit. This is accomplished effectively by taping the terminals, bagging or stacking the batteries in a uniform manner where the terminals cannot contact each other, and securing them to prevent movement during transportation.

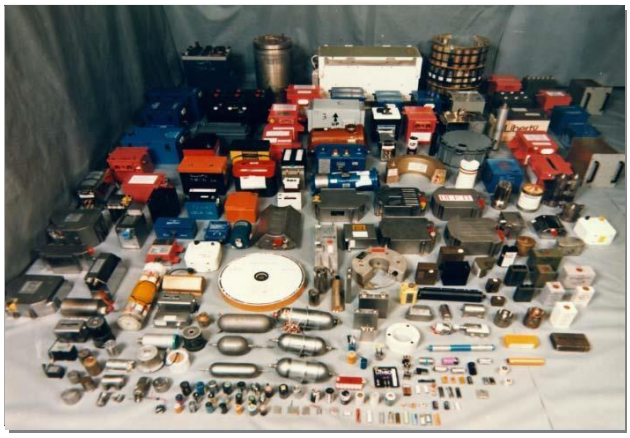
Some battery chemistries, like lithium, are susceptible to catching fire internally when shorting and require additional precautions to prevent fires. Insulating terminals and avoiding flammable packaging materials can limit the hazards associated with these battery chemistries. Poly or fiberboard packaging should be avoided whenever possible; lithium batteries should be segregated from other battery chemistries and transported in metal containers whenever practical.

Familiarization with the Hazardous Materials Safety Regulations as well as your local, federal and State Environmental regulation is recommended prior to managing of your spent batteries. This document is provided to aid our clients in the handling of batteries in the safest and most environmentally sound manner. The information contained herein is supplemental and not meant to replace any existing regulations or other agency recommendations but rather to provide examples of basic safety practices. We recognize that today there are many different chemistries, sizes and shapes of batteries. There are also many variations of packaging that can all be considered safe and effective ways to transport batteries however, there are two rules that should always be followed: dry batteries greater than 9 volts, including all lithium batteries and wet cell batteries, should always be protected against short circuit and secured from movement during transportation.

The Department of Transportation (DOT) recognizes that batteries represent a potential fire and explosive danger when improperly packaged. The Pipeline and Hazardous Materials Safety Administration (PHMSA) has provided safety announcements and continues to revise the regulations in response to the safety concerns presented by improperly packaged batteries. The Consumer Products Safety Commission has issued recalls for certain lithium chemistry batteries and the products containing them. Please be reminded that batteries can present unique hazards for the generators, transporters, and facilities that routinely handle them. These recommendations, when properly implemented, provide a means of ensuring battery packages meet current transportation safety regulations and will reduce the likelihood and severity of an incident.

Battery Identification

Batteries come in many different shapes, colors and sizes. If you cannot identify your batteries, the internet can be a great resource for information. Most batteries have the chemistry clearly marked somewhere on the outer packaging. Part numbers, manufacture's name or model numbers may aid identification via web-search. Always request an MSDS from you supplier.

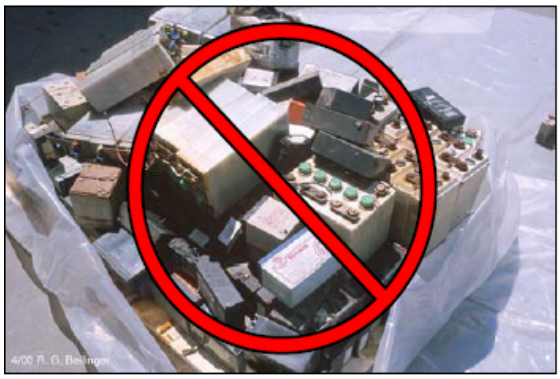


All batteries should be handled with care and packaged in a manner that prevents short circuits and the dangerous evolution of heat. Large packages should be secured in a manner that prevents shifting during transportation.

Large batteries should be uniformly stacked, layered with insulation and secured or banded on to their pallets.

Small batteries
and cells with a rating greater than 9 volts, all wet chemistry batteries and all lithium batteries should be protected against short circuit or prevented from becoming oriented in a manner that allows the creation of a circuit, and packaged in a manner that prevents excessive movement.

This will eliminate a short from occurring and the dangerous evolution of heat.



Batteries should never be stored on the open ground, stacked in loose piles or mixed with incompatible chemistries.

Poor housekeeping can lead to spills, reactions, electrical shorts and fires. Failure to adhere to all hazardous materials safety and environmental regulations can lead to costly clean ups, fines and even imprisonment.

General Safety Practices

Sealed Lead Acid Batteries

These photos show several types of small *Sealed Lead Acid Batteries*. They may also be referred to as *absorbed glass mat* batteries (AGM). This type of battery is designed for both mobile and stationary applications. The name (sealed lead-acid) is derived from the design characteristics that include a sealed maintenance free container and an absorbed, gel electrolyte. They are also referred to as *absorbed glass mat* batteries (AGM).

When properly insulated, the metal contact points are completely covered with a non-conductive material, usually something as simple as "tape", this prevents improper discharging and an accidental short circuit.

Gates Style Sealed Lead Acid Batteries

The Gates style battery is another type of sealed lead acid battery again designed for mobile and stationary applications. Similar to gel cell batteries, its characteristics include a sealed maintenance free container and an absorbed electrolyte layered between the anode and cathode plates.

As with all lead acid batteries, when properly insulated, the metal contact points of the Gates Style are completely covered with tape or other non-conductive material to prevent improper discharging or other reaction from resulting. Sometimes, these batteries are manufactured in banks or multi-celled units. In these instances, cutting and removing the terminals may provide adequate insulation. Larger batteries may be sufficiently protected from short circuit by stacking them or orienting them in a manner that prevents terminal contact and movement.

Lithium Batteries

Aggressive development of high-energy and high-density batteries began in the 1960's. Lithium, alloys, and/or lithium salts, used as the anode, quickly became the material of choice due to its lightweight, high electrochemical equivalence, high voltage and good conductivity. Most lithium batteries were first used in the 1970s for specific military applications, but their use was limited as suitable cell structures, formulations and safety had to be considered.

Though there are many formulations used in modern lithium battery chemistries they can be divided into two categories: lithium Ion (rechargeable) and Lithium Primary (non-rechargeable batteries.) There are significant safety concerns unique to each format.

Primary batteries are often comprised of individual cells capable of generating 3 Volts of electricity. Although there are always new chemistries being developed, two commonly used primary chemistries are Sulfur Dioxide ($LiSO^2$) and Thionyl Chloride ($LiSOCl^2$). These types of batteries contain an electrolyte that is pressurized in the canister

(approximately 45PSI) to remain liquid. Though the electrolyte may not be flammable the pressure and the high energy concentrations found in this design present unique storage and handling challenges. These batteries should not be exposed to excessive heat and should be stored and packaged in a manner that prevents short circuit.

Lithium ion batteries or Li-ion batteries contain solvent based electrolytes and can vigorously burn when exposed to heat or ignition sources such as a spark or ungrounded circuit. For this reason all Li-ion batteries should be insulated and stored in non-flammable packaging away from heat, open flame or other flammable and or reactive materials.

Bagging batteries or cells individually and or taping the terminals is always advised. Insulating one terminal of every cell effectively eliminates the possibility of a circuit external to any battery. Therefore it is not necessary to cover the entire battery with tape or non-conductive materials. It is also not safe to stack batteries or cells end to end when the terminals or connectors are exposed, such as a coin or

cylindrical battery.
This can create a circuit in series and generate enough heat to rupture the cells from the rapid expansion of the electrolyte. Batteries that rupture in a confined space may cause fire and or explosions and should be considered volatile hazard.

Transportation regulations prohibit the use of bulk containers for the shipment of lithium batteries; and in most cases require combination packages. Transportation safety regulations for lithium batteries can be found in 49 CFR 173.185.

Small Cell Lithium Batteries

Today's lithium batteries have been designed utilizing different chemistries for usage in a variety of applications. The photo above is a small example from a myriad of household and commercial applications.

When using tape to effectively insulate batteries please ensure that marking remain visible to aid in the identification of batteries downstream.

Wet Alkali Batteries

Wet filled Nickel Iron and nickel cadmium batteries are alkali-based batteries that commonly use potassium hydroxide as an electrolyte. These batteries contain free flowing liquid electrolyte and should be managed in a manner that prevents spills and leaks.

Potassium hydroxide is very caustic and should be handled with caution.

Again, when properly insulated, the metal contact points of the batteries are completely covered with a non-conductive material to prevent shorting.

A comment on UNIVERSAL WASTE

The requirements of 49 CFR §172 and §173 apply to all battery shipments. The Universal Waste regulations do not release generators or transporters from any of the transportation safety regulations. Furthermore, 49 CFR §172.704 requires that each HAZMAT employee complete training described as general awareness/familiarization and function specific. A HAZMAT employee is defined in 49 CFR §171.8 as "any person, who loads, unloads or handles hazardous materials… or who prepares hazardous material for transportation…" It is the responsibility of the employer to provide this training and to abide by all of the Hazardous Materials Regulations.

Though the regulations specific to batteries are too voluminous to contain herein, a list of the existing regulations pertaining to the preparation, packaging and transportation of batteries can be found in the table on the following page.

Battery Marking/Packaging

Battery Type	Proper Shipping Name	Hazard Class	ID number	Packing Group	Applicable Special Provisions	Packaging 173.**
Applicable to most consumer dry cell re-chargeable batteries including: Ni-Cad, NiMH, Zinc Carbon, Mercury, and Alkaline ***F*** [1]	Waste Batteries, Dry, Sealed, NOS	n/a	n/a	n/a	**130**	
Industrial application dry alkaline batteries	Waste Batteries, Dry, containing Potassium Hydroxide Solid	8	UN3028	PG III	237	213 ***F*** [2]
Flooded lead acid batteries including; industrial, automotive and standby power batteries ***F*** [1]	Waste Batteries, Wet Filled with Acid	8	UN2794	PG III	None	159
Alkaline wet cell batteries including: Ni-cad (industrial style), Ni-Iron, Zinc Carbonaire ***F*** [1]	Waste Batteries, Wet Filled with Alkali	8	UN2795	PG III	None	159
Sealed acid batteries including: Gel cell and gates type ***F*** [1]	Waste Batteries, Wet, Non-Spillable	8	UN2800	PG III	None	159, 159 (a)
Lithium batteries, lithium-ion and primary lithium chemistries ***F*** [1]	Waste Lithium Batteries	9	UN3090	PG II	29, 188, 189, A54, A55, A100	185(d)
	Waste Lithium Batteries, Contained in Equipment		UN3091		29, 188, 189, A54, A55, A101, A104	
Damaged primary lithium batteries, shipped in schedule 40 PVC tubes ***F*** [1]	Waste Lithium Batteries	9	UN3090	PG II	29, 188, 189, A54, A55, A100	185(d)
Drained Lead-acid Batteries	Waste Environmentally Hazardous Substance, Solid, NOS	9	UN3077	PG III	8, 146, 335, B54, IB8, IP3, N20, T1, TP33	213
~~Broken, burnt, drained or damaged batteries ***F*** [3]~~	~~Hazardous Waste Solid NOS~~	~~9~~	~~NA3077~~	~~PG III~~	~~B54, IB8, IP2, T1, TP33~~	~~213~~

F[1] Batteries meeting the definition of a hazardous material per CFR 49.
F[2] Bulk packagings are not authorized.
F[3] Batteries meeting the description of a hazardous waste per CFR 40.

Example PSN Format for Shipping Papers: "UN3090, Waste Lithium Batteries, 9, PG II."

Additional California Descriptions

Non-RCRA Hazardous Waste Solid	May be used when shipping *Alkaline Batteries* in California; special provision 130 applies.

Universal Waste Battery Descriptions

Universal Waste Batteries *Waste Batteries* *Used Batteries*	Applicable Labeling/Marking for *Universal Waste Batteries* when shipped in accordance with 40 CFR §273 (CCR Title 22 §66273).

ReVolt Recycling