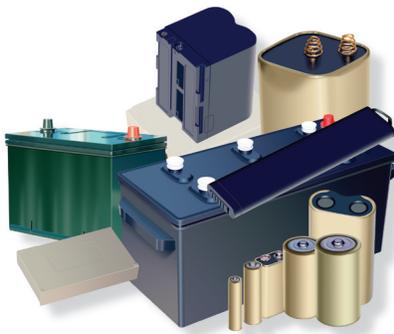


# DRAFT

SHIPPING  
BATTERIES

**SAFELY BY AIR**

What You Need To Know



U.S. Department  
of Transportation  
**Pipeline and  
Hazardous Materials  
Safety Administration**

**SHIPPING BATTERIES SAFELY BY AIR: WHAT YOU NEED TO KNOW**



This guide is written to help you ship batteries safely by air. It is not a substitute for the Hazardous Materials Regulations (HMR; 49 CFR 100-185). While every effort has been made to provide a simplified guide consistent with the HMR, if there is any instance in which this guide is inconsistent with the HMR, the regulations themselves are the final authority for proper shipping procedures. If you have questions about a specific shipment, please call our Info-line at (800) 467-4922.

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# Introduction

## **Why are Batteries regulated in transportation?**

Batteries are regulated in transportation because batteries contain stored energy and hazardous materials such as corrosive or flammable electrolytes. Dangers associated with batteries include chemical burn, fire, and electrical shock. Lithium batteries are considered a hazardous material for purposes of transportation because they can overheat and ignite in certain conditions and, once ignited, can be difficult to extinguish. In general, the risks posed by batteries are a function of battery size and chemistry. Certain battery types are of greater concern when transported, for example unlike standard alkaline batteries, most lithium batteries manufactured today contain a flammable electrolyte and have a higher energy density. In addition, although an infrequent event, a lithium battery is susceptible to thermal runaway, a chain reaction leading to a violent release of its stored energy.

Batteries are woven into the fabric of modern American life. They power portable computers, phones, and audio devices. They make possible motorized wheelchairs and cordless tools. We have come to depend on batteries for an increasingly mobile lifestyle.

Today's batteries pack more power than ever, making possible a steadily growing number of battery-powered devices on the market. But with that power comes responsibility. Batteries can be dangerous if not safely packaged and handled when transported. Misused, mishandled, improperly packaged, improperly stored, overcharged, or defective batteries can short circuit, overheat, and sometimes cause a fire. In addition, some of the chemicals in batteries can pose hazards, if they are released.



**Fig. 1**  
Battery incident

Because of these hazards, batteries and battery-powered equipment are regulated in transportation. The Hazardous Materials Regulations (HMR; 49 CFR parts 171-180) include provisions for packaging, communication (package marking, labeling and shipping papers) and handling. Other countries similarly regulate batteries and battery-powered devices, as do international bodies, such as the International Civil Aviation Association (ICAO).

The purpose of all these regulations is to protect the safety of people and property. If the applicable requirements are not followed, these shipments may contribute to fires, injuries, or other incidents during transport. Failure to comply with the applicable regulations may result in a fine or even jail time. Check with your carrier for their specific additional requirements.

Within the U.S. Department of Transportation (U.S. DOT), the Pipeline and Hazardous Materials Safety Administration (PHMSA) works to ensure the safe transportation of hazardous materials by highway, rail, water or air. The Federal Aviation Administration (FAA) enforces those regulations, and issues and enforces other regulations pertaining to the safety of transportation by air.

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PHMSA prepared this brochure with the help of FAA, and with input from experts in the battery and shipping industries, to assist you in safely packaging batteries for transport by air. Whether you are shipping a single battery, a palletized load of batteries, or a battery-powered device, the safety of your package, and of the people who handle it along the way, depends on compliance with these regulations.

This guide will help you determine how to safely package batteries and battery-powered devices. Citations referencing the HMR are provided in each of this booklet's sections. This booklet was prepared with great attention to the HMR, but if there is any conflict between the booklet and the regulations, the HMR is the final authority.

**Fig. 2**

Fully enclose batteries in plastic blister wrap, pasteboard, or other inner packaging that will protect each battery from making contact with another battery or any item that is capable of short-circuiting

**Protecting Batteries from Damage and Short Circuits**

Batteries may spark, overheat or even catch fire if they short-circuit. A short circuit can happen any time something which conducts electricity touches both terminals on a battery. For example, a tool, a set of keys, or wiring could bridge the terminals, creating a short circuit. Additionally, damaged batteries may lead to short-circuiting or contribute to a fire through release of stored energy or release hazardous contents such as corrosive battery fluid.



# DRAFT

This guide will help you prepare packages for air transportation in accordance with the HMR, but it remains important to use common sense when preparing packages containing batteries for transportation, or handling such packages or their contents during transportation.

## **Batteries and battery-powered devices can be a safety risk when transported by air.**

Short circuits and fire may result from mishandling (e.g., crushing or dropping) batteries. Packaging batteries to protect terminals, especially from metallic objects, increases safety when transporting batteries. Packaging battery-powered devices to prevent inadvertent activation also contributes to increased safety.



# Lithium Batteries

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## What's different about lithium batteries?

Rechargeable lithium batteries (also called lithium ion (Li-ion), or secondary lithium batteries,) and non-rechargeable lithium batteries (also called lithium metal, or primary lithium batteries,) provide more energy and a longer operating life than batteries which use other chemistries. They have the potential to generate a significant amount of heat or catch fire if damaged or improperly packaged, cared for, or designed than do other batteries. In recognition of these facts, the U.S. and international regulations pertaining to the transportation of lithium cells and batteries have changed significantly over the last five years.

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## How To Use This Section



This section is divided into four types of pages: **Beige** bordered pages, such as this one, discuss lithium batteries in general; **Green** bordered pages discuss small lithium batteries; **Gold** bordered pages discuss medium lithium batteries; and **Red** bordered pages discuss large lithium batteries.

You can safely and easily ship most consumer-type lithium batteries, both of the rechargeable and non-rechargeable varieties. These batteries include camera batteries, original equipment notebook computer batteries, and cell phone batteries.

Non-rechargeable (i.e., metal/primary) lithium batteries may not be transported aboard passenger aircraft and packages containing those batteries must be marked:

**“PRIMARY LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT”**

or

**“LITHIUM METAL BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT”**

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## IS YOUR LITHIUM BATTERY SMALL, MEDIUM, OR LARGE?

The regulations for shipping lithium batteries are based on the size of the battery or cell to be shipped (a battery is made up of one or more connected cells.) These size categories depend on the lithium (Li) content of a non-rechargeable battery or cell, or the equivalent lithium content (ELC) for rechargeable lithium batteries or cells.

Battery and Cell Category Definitions			
	Small (no more than)	Medium (between)	Large (more than)
<b>Cells</b>			
Non-Rechargeable	1.0 g Li	1.0 g and 5 g Li	5 g Li
Rechargeable	1.5 g ELC	1.5 g and 5 g ELC	5 g ELC
<b>Batteries</b>			
Non-Rechargeable	2.0 g Li	2.0 g and 25 g Li	25 g Li
Rechargeable	8 g ELC	8 g and 25 g ELC	25 g ELC

Most consumer type lithium batteries fall into the category of “small” lithium batteries under the regulations.

Medium lithium batteries include “extended life” batteries marketed as aftermarket additions for notebook computers, and some batteries used by audiovisual professionals.

Most large batteries are for use by military and industry, not by the consumer, although some batteries for mobility aids and scooters, may fall under the “large” category.

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**On these pages:** we will provide information on how these categories apply to your battery or cell. Determining the lithium content or equivalent lithium content of a battery or cell can be complex, so examples are also listed, as are watt-hour equivalencies. If the information for determining watt-hour rating, lithium content, or ELC is not on your battery or in the information provided with the battery, contact the manufacturer or distributor for more information. The table below provides some examples of small, medium and large lithium batteries.

<b>Real World Examples of Lithium Batteries</b>	
	<b>Small lithium batteries and cells</b> include cell phone batteries, camera batteries, and original batteries for notebook computers. The eight gram equivalent lithium content at the top of the “small” range of rechargeable batteries provides about 100 watt-hours of power.
	<b>Medium lithium batteries and cells</b> include larger batteries and cells a consumer might purchase, but not without noticing their larger size — examples include some extended life batteries for notebook computers, and batteries used by audiovisual professionals. A “medium” rechargeable battery provides between 100 and 300 watt-hours of power.
	<b>Large lithium batteries and cells</b> are primarily those used in industry. A large rechargeable battery provides over 300 watt-hours of power (over 25 g of equivalent lithium content.) Large batteries may be found in some electric and hybrid vehicles, as well as some mobility devices and scooters.

## WHAT REQUIREMENTS APPLY TO SHIPPERS OF “SMALL” LITHIUM BATTERIES?

Small lithium batteries and cells must pass tests found in the UN Manual of Tests and Criteria.

Packaged cells or batteries must be separated in a way to prevent short circuits and must be packed in a strong outer packaging or be contained in equipment.



**Fig. 3**  
Sample  
Packaging



**Fig. 4**  
Improper Pack-  
aging:

Loose batteries can  
cause  
dangerous short-  
circuit



### Additional Requirements:

- Leave devices in the off position. Take effective measures to ensure the device can not activate during transportation.
- Properly cushion items to prevent movement.
- Place contents in a sturdy outer container.



- Packaging requirements for “small” lithium batteries are found in § 172.102, Special Provision 188.
- Provisions for airline passengers are found in § 175.10(a)(17).

### **Aircraft Quantity Limits for Small Lithium Batteries:**

Primary (non-rechargeable) lithium batteries and cells are forbidden for transport aboard passenger carrying aircraft (see Page 9). Secondary (rechargeable) small lithium batteries and cells are authorized aboard passenger carrying aircraft.

### **A package containing more than 24 lithium cells or 12 lithium batteries must be:\***

- Marked to indicate that it contains lithium batteries and that special procedures should be followed in the event the package is damaged.
- Accompanied by a document indicating that the package contains lithium batteries and special procedures should be followed in the event that the package is damaged.
- Capable of withstanding a 1.2 meter drop test in any orientation without damage to cells or batteries contained in the package, without shifting of the contents that would allow short circuits and without release of package contents; and
- No more than 30 kg (66 pounds).

*\*Does not apply to cells or batteries in or contained in equipment.*

## WHAT REQUIREMENTS APPLY TO SHIPPERS OF “MEDIUM” LITHIUM BATTERIES?

Medium lithium batteries and cells must pass tests found in the UN Manual of Tests and Criteria.

Batteries or cells must be separated so as to prevent short circuits and must be packed in a strong outer packaging or be contained in equipment.



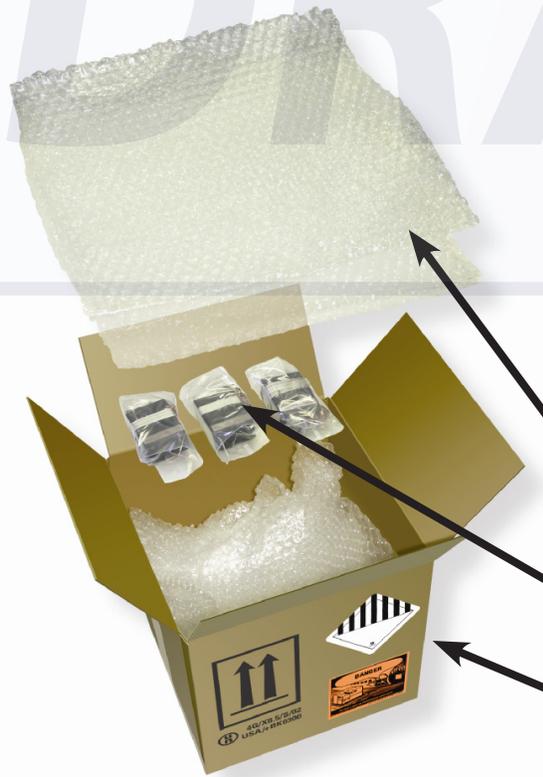
Two spare “medium” lithium batteries are allowed in carry-on luggage. Provisions for airline passengers are found in § 175.10(a)(17).

### **Aircraft Quantity Limits for Medium Lithium Batteries:**

Primary (non-rechargeable) lithium batteries and cells are forbidden for transport aboard passenger carrying aircraft (see Page 9). Secondary (rechargeable) lithium batteries and cells are authorized aboard passenger carrying aircraft in packages that do not exceed a gross weight of 5 kg (11 pounds).

**WHEN TRANSPORTED BY AIRCRAFT, FOLLOW THE RULES FOR “LARGE” BATTERIES ON PAGES 16-17.**

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**Fig. 5**  
Sample Packaging:  
Fully Regulated UN3090  
Applies to “medium” and “large”  
batteries (see § 172.102, Special  
Provision 189)

Cushioning

Lithium Batteries  
Individually Packaged

UN Specification Packaging

When transporting “medium” lithium batteries by highway or rail, requirements are found in §§ 173.185 and 172.102, Special Provision 189. You must mark the outside of each package:

“LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD  
AIRCRAFT AND VESSEL”

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**“Large” lithium batteries and cells are fully regulated by the HMR.**

Complete regulatory requirements for “large” lithium batteries are found in § 173.185



# DRAFT

## WHAT REQUIREMENTS APPLY TO SHIPPERS OF “LARGE” LITHIUM BATTERIES?

“Large” lithium batteries and cells must:

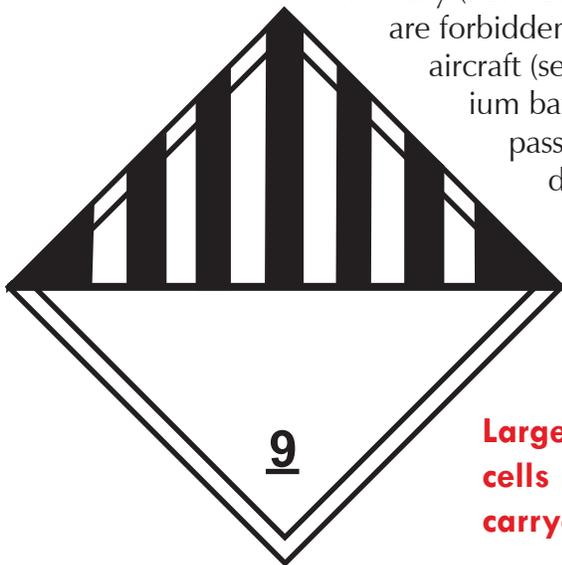
- Pass the tests in the UN Manual of Tests and Criteria.
- Be packaged in UN Specification combination packagings.

Shipments of “Large” lithium batteries and cells must be:

- Marked and labeled in accordance with the HMR as Class 9.
- Accompanied by a shipping paper prepared in accordance with the HMR describing the batteries.

### Aircraft Quantity Limits for Large Lithium Batteries:

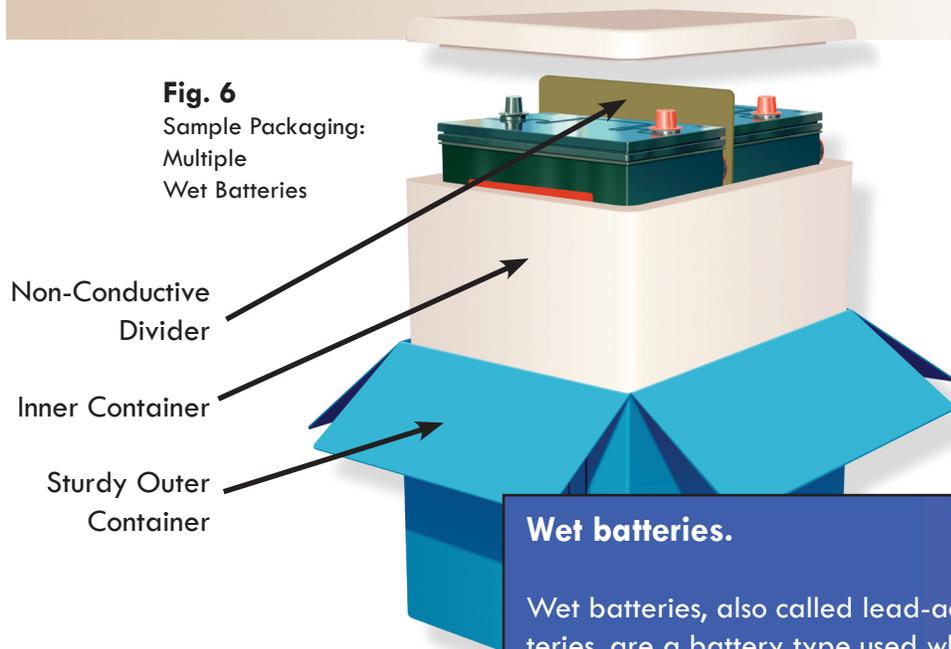
Primary (non-rechargeable) lithium batteries and cells are forbidden for transport aboard passenger carrying aircraft (see Page 9). Secondary (rechargeable) lithium batteries and cells are authorized aboard passenger carrying aircraft in packages that do not exceed a gross weight of 5 kg (11 pounds).



**Large lithium batteries and cells may not be placed in carry-on or checked luggage.**

# DRAFT

## Wet Batteries



**Fig. 6**  
Sample Packaging:  
Multiple  
Wet Batteries

Non-Conductive  
Divider

Inner Container

Sturdy Outer  
Container

### Wet batteries.

Wet batteries, also called lead-acid or lead-alkali batteries, are a battery type used where weight is not a concern. These batteries are used in automobiles, forklifts, wheelchairs, Uninterruptible Power Supply (UPS) systems, and many other applications. Hazards associated with these batteries include burns from the corrosive electrolyte fluid and heat caused by short circuits.

\*Wet battery requirements are found in the HMR under § 173.159.

- **UN2794 – Batteries, wet, filled with acid, electric storage.**
- **UN2795 – Batteries, wet, filled with alkali, electric storage.**

### **Class 8 Corrosive**



**CORROSIVE**

#### **Packaging Requirements**

Wet batteries are defined as electric storage batteries, containing electrolyte acid or alkaline corrosive battery fluid.

Wet batteries must be completely protected to prevent short circuits (e.g., by the use of non-conductive caps that entirely cover the terminals). In general, they may not be packed with other materials (exceptions are provided for battery acid/alkali fluid, dry cell batteries, and mechanical equipment such as battery chargers in § 173.159 paragraphs (g) and (h) and in §§ 173.220 and 173.222). For transportation by aircraft, the packaging for wet batteries must incorporate an acid- or alkali-proof liner, or include a supplementary packaging with sufficient strength and be adequately sealed to prevent leakage of electrolyte fluid in the event of a leak.

Batteries must be positioned in the orientation that is least likely to result in a short circuit. Battery terminals may not be relied upon to support weight.

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## Non-Spillable Batteries



**A non-spillable battery** is a battery that is capable of passing the vibration and pressure differential tests as provided by § 173.159(d). Non-spillable batteries must be marked:

“NONSPILLABLE” or “NONSPILLABLE BATTERY.”



- **UN2800 – Batteries, wet, non-spillable, electric storage**

**A non-spillable wet electric storage battery is not subject to the HMR when:**

- The battery meets certain testing requirements (see § 173.159(d))
- The battery and its outer packaging are plainly and durably marked “NONSPILLABLE” or “NONSPILLABLE BATTERY”, and
- The battery is protected against short circuits (e.g., by the use of non-conductive caps that entirely cover the terminals).

When shipping a non-spillable battery, check the regulations carefully to be sure all of the requirements have been met. That includes a non-spillable battery contained in or packed with a piece of equipment.

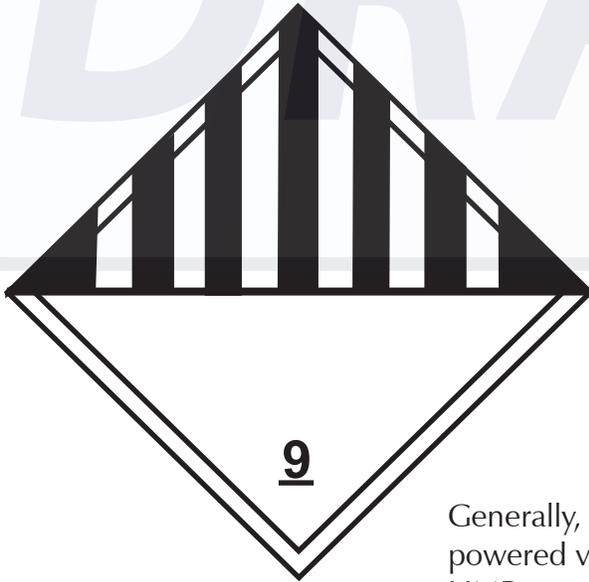
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# Batteries Installed in Equipment



The HMR include a number of provisions applicable to batteries installed in vehicles, machinery, or other types of equipment. Section 173.220 includes requirements for shipment of internal combustion engines, self-propelled vehicles, mechanical equipment containing internal combustion engines, and battery powered vehicles or equipment.

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- **UN3171**  
**Battery-powered vehicle or**  
**Battery-powered equipment**

### **Class 9 Miscellaneous**

Generally, this section relaxes requirements for battery-powered vehicles, machinery, and equipment from the HMR provided they meet certain minimal requirements.

#### **Packaging Requirements:**

- Batteries must be securely installed.
- Wet batteries must be fastened in an upright position.
- Batteries must be protected against short circuits (e.g., by the use of non-conductive caps that entirely cover the terminals) and leakage, or removed and packaged separately.
- When transported by aircraft: shipping papers, emergency response information, notification of pilot-in-command, general packaging requirements, and the requirements in § 173.27.

Battery-powered wheelchairs and other mobility devices are subject to relaxed requirements for transport on passenger aircraft under certain conditions. These conditions can be found in § 175.10 of the HMR.

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## Dry Batteries

(Excluding Lithium)



These are sealed batteries that are normally used in flashlights or small appliances. Examples include alkaline, nickel metal hydride, nickel cadmium, and carbon zinc batteries. In other words, AA, AAA, D-Cell, C-Cell, etc.\* These batteries include both non-rechargeable types (sometimes called alkaline batteries) and rechargeable types (nickel metal hydride and nickel cadmium).

*\*Note, some AA, AAA, and 9-volt batteries are made using lithium chemistries. Dry batteries do not include lithium batteries.*

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- **Dry Batteries**

Unless a dry battery is covered by an entry found in the § 172.101 Hazardous Materials Table in the HMR such as “UN3028, Batteries, dry, containing potassium hydroxide solid, electric, storage,” dry batteries are not subject to the HMR when they are properly packaged and protected.

#### Packaging Requirements:

- Batteries must be protected against short circuits (e.g., by packaging in consumer-type blister packagings or the use of non-conductive caps that entirely cover the terminals).
- Batteries must be securely packed in a strong outer packaging in such a manner as to prevent the shifting of contents.

**Fig. 9**  
Sample Packag-  
ing:  
Dry Cell Bat-  
teries  
• Cushioning  
• Divider



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**GOT A  
HAZMAT  
QUESTION?**

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