AC 120-SRACC, Safety Risk Assessments Involving Items in Aircraft Cargo Compartments, and Accompanying Web Site

Presented to: INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION FORUM

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Date: 4/22/2021

Federal Aviation Administration

Genesis of AC & Web Site

- Accidents & Incidents Involving Lithium Batteries
  - Pointed to a Problem
- Testing by FAA & Others
  - Helped Quantify the Problem
- ICAO Multi-disciplinary meetings
  - Need to Assess Cargo & Aircraft Capabilities
- CAST
  - Need for Mitigation Methods
- ICAO Chapter 15 & Update to Annex 6
  - Include Cargo in SMS

FAA recognizes the need to have not only published guidance but a real-time tool to identify evolving Hazards, Risks and Mitigation Methods.

AC + Web Site

FAA Home ▸ Aircraft

- Aircraft Certification
- Aircraft Safety
- General Aviation & Recreational Aircraft
- Repair Stations

Flight Standards Service

Draft Advisory Circulars (ACs) Open for Comment

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Document Title:	AC 120-SRACC, Safety Risk Assessments Involving Items in Aircraft Cargo Compartments
Summary:	This AC provides guidance in assessing the safety risks associated with the transport of various types of items in the aircraft cargo compartment and the value of considering the inherent hazardous properties of these items.

Related Information

- Final Aircraft Certification advisory circulars, other policy documents, and technical standard orders (TSOs) are available on FAA's Regulatory and Guidance Library (RGL)
- Advisory Circulars (ACs)
- FAA Regulations
- Orders & Notices

Comments Due By: March 12, 2021

"DRAFT"

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Safety Risk Assessments Involving Items in Aircraft Cargo Compartments

Date: DRAFT
Initiated by: AFS-300

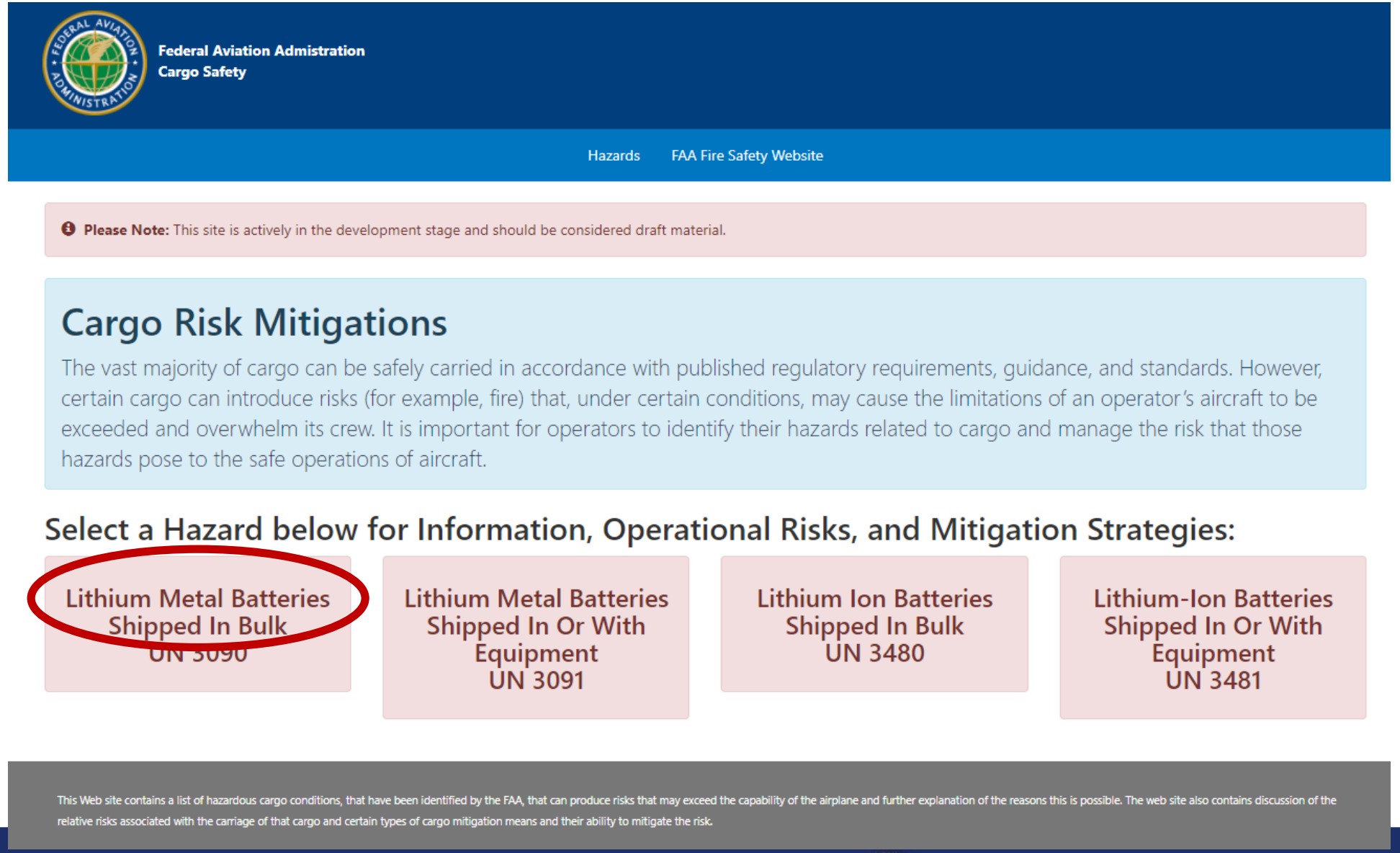
AC No: 120-SRACC
Change:

1 **PURPOSE OF THIS ADVISORY CIRCULAR (AC).** This AC provides guidance in assessing the safety risks associated with the transport of various types of items in the aircraft cargo compartment and the value of considering the inherent hazardous properties of these items. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

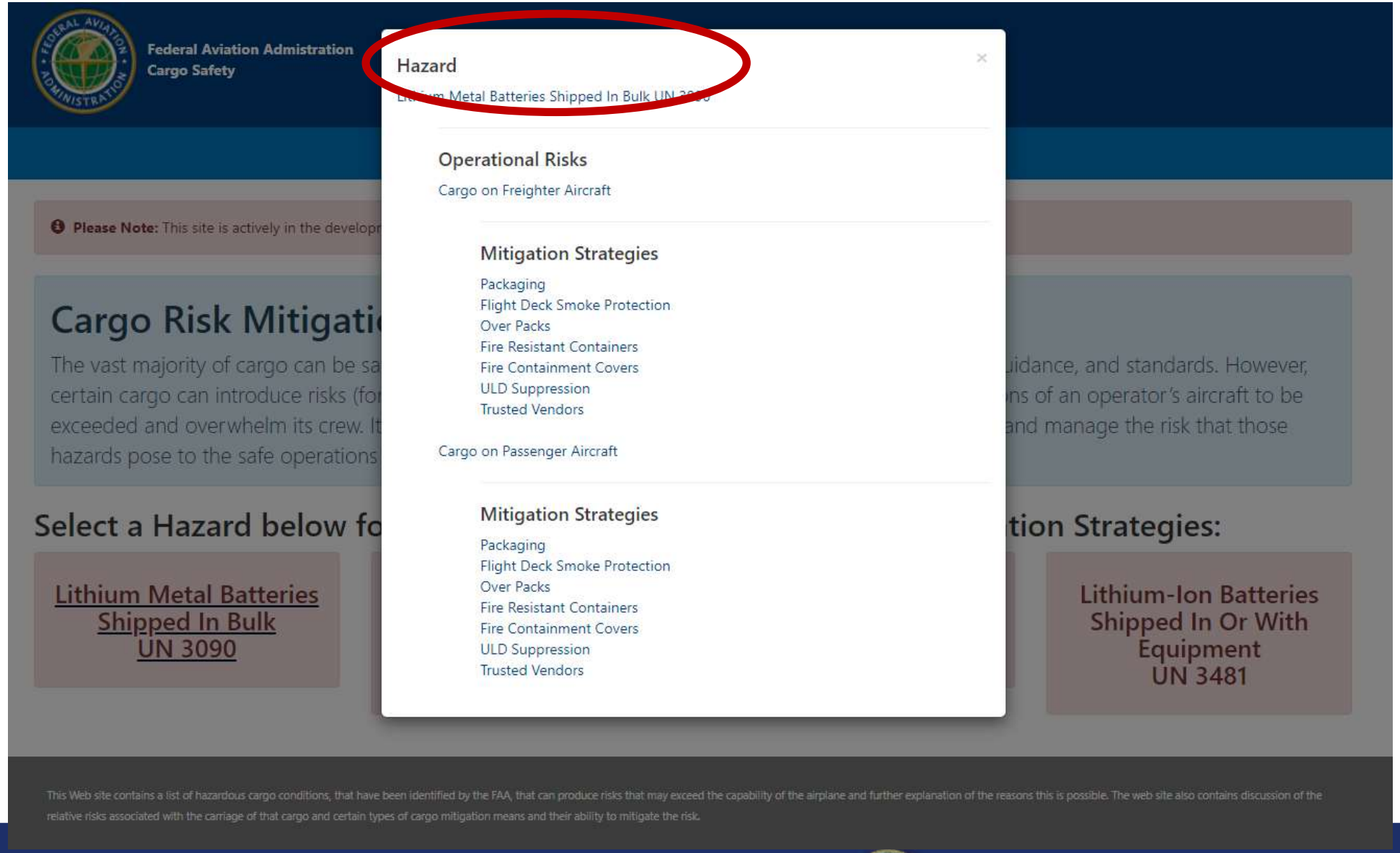
5.2 Fire Event Research. Regulators and industry frequently conduct research on the interaction between the aircraft and items carried in the aircraft cargo compartments and on the properties of these items during fire events. Research and information about topics in this AC are available at https://www.fire.tc.faa.gov/cargosafety.

8.1 Outcomes Associated with the Carriage of Items. Outcomes are the negative events or effects that a hazard can trigger. One hazard can trigger multiple outcomes, and operators should address each potential outcome in a risk assessment. The following is a discussion of the potential outcomes associated with the carriage of items in aircraft cargo compartments and the degree to which current practice mitigates the associated risks. Refer to https://www.fire.tc.faa.gov/cargosafety for a summary of issues the FAA has identified that operators should consider when conducting a risk assessment to address fire safety concerns on the aircraft.

https://www.fire.tc.faa.gov/CargoSafety/



https://www.fire.tc.faa.gov/CargoSafety/



https://www.fire.tc.faa.gov/CargoSafety/

Please Note: This site is actively in the development stage and should be considered draft material.

Lithium Metal Batteries Shipped In Bulk UN 3090

Hazard: Lithium Metal Batteries Shipped In Bulk UN 3090

A single cell (AA, AAA, C, 18650, cr123, etc., usually referred to as a battery by consumers) may be defined as a single encased electrochemical component and a battery (power drill battery, power pack, drone battery, etc.) is two or more cells electrically connected. Non-rechargeable lithium-metal cells and batteries are manufactured in various shapes, sizes, and chemistries depending on the application. The image below: Variety of Lithium-Metal Cells shows examples of cells that may be packaged according to UN 3090.

Lithium-metal cells and batteries are capable of overheating and undergoing a process called thermal runaway. Thermal runaway can occur without warning as a result of various factors, including if the package is damaged, overheated or improperly packed. Thermal runaway can also occur on its own due to manufacturing defects, without any environmental or mishandling factors. See video: Battery Thermal Runaway

The outcome of thermal runaway varies depending on the specific chemistry of lithium-metal, the size of the cell or battery, whether it's fully charged, the individual manufacturer design as well as orientation and configuration in the package. The more dangerous hazards can include violent ejection of flames and battery components, emission of flammable gas that can build up and later explode or an explosion of the cell itself. Less hazardous outcomes include an emission and dissipation of flammable vapors without ignition or accumulation of gas or a thermal runaway event that catches fire but self-extinguishes. See videos: Flammable Gas Buildup and Explosion and Explosion of Cell Itself. Research on flammable gasses released: Flammable Gases

An important factor related to the hazard of thermal runaway is an event called "thermal runaway propagation". Propagation occurs when the heat from one battery or cell causes an adjacent battery or cell to also undergo thermal runaway. This can repeat itself over and over until an entire pallet of batteries has undergone thermal runaway creating enormous amounts of heat, smoke, and flammable gases. For this reason, mitigation techniques can be employed to prevent propagation if thermal runaway of a single cell does occur. See video: <need to upload video>

UN 3090 governs the shipment of non-rechargeable lithium-metal cells or battery packages. The associated packing instructions are P.I. 968. Within P.I. 968, lithium-metal cells or batteries can be packaged and shipped according to: Section 1A, Section 1B or Section II. (Packing Instruction 968).

UN 3090 can encompass a variety of different types and configurations of lithium-metal cells and batteries, making it difficult to assess the hazard associated with the package simply by looking at the label alone. For example, a shipment of cells or batteries posing a significant thermal runaway hazard may use the same packaging and labeling as a shipment containing comparatively safe and benign lithium-metal cells and batteries. It is important to keep this in mind when creating a safety management plan for the transportation of lithium-metal cells and batteries.

Links to more details of above mentioned concepts

- **Images (also provided in above text)**
  - Variety of Lithium-Metal Cells
- **Videos (also provided in above text)**
  - Battery Thermal Runaway
  - Flammable Gas Buildup and Explosion
  - Explosion of Cell Itself

https://www.fire.tc.faa.gov/CargoSafety/

- **Hazards**
  - **Energy**
    - Energy Release by Rechargeable Lithium-Ion Batteries in Thermal Runaway
    - Measuring Energy Release of Lithium-ion Battery Failure Using a Bomb Calorimeter
  - **Propagation**
    - Passive Protection of Lithium Battery Shipments
    - Fire Hazard Analysis for Various Lithium Batteries
  - **Flammable Gases**
    - Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft
    - Lithium Battery Thermal Runaway Vent Gas Analysis
    - Flammability Limits of Lithium-Ion Battery Thermal Runaway Vent Gas in Air and the Inerting Effects of Halon 1301
    - Thermal Runaway Initiation Methods for Lithium Batteries
    - Impact of Lithium Battery Vent Gas Ignition on Cargo Compartment Fire Protection
    - Summary of FAA Studies Related to the Hazards Produced by Lithium Cells in Thermal Runaway in Aircraft Cargo Compartments
- **Reports**
- **Presentations**

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Operational Risks:

Cargo on Freighter Aircraft

Cargo on Passenger Aircraft

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This Web site contains a list of hazardous cargo conditions, that have been identified by the FAA, that can produce risks that may exceed the capability of the airplane and further explanation of the reasons this is possible. The web site also contains discussion of the relative risks associated with the carriage of that cargo and certain types of cargo mitigation means and their ability to mitigate the risk.

https://www.fire.tc.faa.gov/CargoSafety/

Federal Aviation Admistration
Cargo Safety

Hazards FAA Fire Safety Website

Please Note: This site is actively in the development stage and should be considered draft material.

Lithium Metal Batteries Shipped In Bulk UN 3090 / Cargo on Freighter Aircraft

Operational Risk: Cargo on Freighter Aircraft

A build-up of flammable gases, resulting from thermal runaway of lithium metal batteries, creates the risk of a catastrophic explosion. Some cargo compartments have built-in fire extinguishers. Heat and smoke generated from battery fires can damage the liners or pressure relief panels. This can cause the extinguishing agent to leak, making it less effective against the threat of fire. See video: 727 Explosion. See research on flammable gases released: Flammable Gases.

High temperatures and flammable gases can overwhelm standard and more fire-resistant shipping containers. A lithium metal cell fire can sustain itself even in low oxygen environments and hence pose the highest threat to the aircraft. The high temperatures can melt the polycarbonate material. This allows the fire to spread among other cargo or aircraft systems. If the container remains intact, large quantities of flammable gases can accumulate. This can result in a large fire or explosion. An explosion can cause catastrophic structural or system failure. See video: Shipping Container Explosion. See research on flammable gases released: Flammable Gases.

Class C cargo compartments have built-in fire extinguishers. The smoke detection and fire extinguishing systems in the lower cargo compartment can detect and suppress most fires. However, the current suppression systems are not adequate to protect against lithium battery fires. This video shows the threat of bulk shipments of lithium batteries in the lower cargo compartment. The agent suppresses the fire but is not able to cool down the cells. As a result, thermal runaway continues to propagate among cells, generating a large volume of flammable gases that could result in a catastrophic explosion. See research on flammable gases released: Flammable Gases.

The smoke generated from battery fires can overwhelm the environmental control systems (ECS). This can allow smoke to enter the cockpit and create a low visibility environment. Keeping smoke out of the cockpit is essential for a safe flight. At a minimum, the pilot must maintain a clear unobstructed view of the flight instruments. Smoke in the cockpit can obscure the pilots' vision and result in loss of control of the aircraft.

Pallets of lithium metal batteries can travel in cargo holds. The pallet cover can melt due to the high temperatures. This can result in shifting cargo during maneuvering. An unbalanced cargo load can cause the loss of control of the aircraft.

Additional Links

- **Links to more details of the above-mentioned risks**

https://www.fire.tc.faa.gov/CargoSafety/

- **Hazards**
  - **Energy**
    - Energy Release by Rechargeable Lithium-Ion Batteries in Thermal Runaway
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Mitigation Links:

Packaging	Flight Deck Smoke Protection	Over Packs
Fire Resistant Containers	Fire Containment Covers	ULD Suppression
Trusted Vendors		

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