

Rising Incidents, Shifting Responsibility: Lithium Batteries in the Aviation Cargo Supply Chain





“ We need to promote the quality of safety, not the advantage of the cheap. ”
– Industry Shipper

Lithium batteries, particularly and specifically lithium-ion batteries, are a routine part of global air cargo — and an increasingly urgent safety hazard, considering the risk of fire from thermal runaway these batteries present if damaged, substandard, or malfunctioning. As consumer demand for low-cost, battery-powered products has surged, so too have incidents of thermal runaway in aviation cargo operations.

Data from UL Standards & Engagement’s Thermal Runaway Incident Program shows a 40% increase in reported lithium battery incidents in air cargo between 2021 and 2025, underscoring a growing challenge for the industry.

This report examines why these incidents continue to rise and where risk is entering the cargo supply chain. Its findings are grounded in a mixed-methods approach that combines incident data analysis with extensive qualitative research. ULSE conducted in-depth interviews

and focus groups with cargo airlines, regulators, manufacturers, freight forwarders, e-commerce stakeholders, and small and individual shippers across the global battery supply chain. These conversations were designed to surface real-world practices, pressures, and points of failure that are not visible in regulations or incident reports alone.

Together, the data and stakeholder insights reveal a system strained by fragmentation, uneven accountability, and commercial pressures that too often prioritize speed and cost over safety. Understanding the core drivers of thermal runaway risk in air cargo, the conditions that allow that risk to persist, and the opportunities to strengthen accountability, coordination, and safety, will lead to a stronger and more secure global supply chain.

Key Takeaways

1 Thermal runaway incidents in cargo continue to rise alongside consumer demand for low-cost, battery-powered products.

Thermal runaway incidents in cargo continue to rise, with a 40% increase since 2021. With greater consumer demand for products powered by lithium batteries, there are more batteries in cargo that could become a threat — exacerbated by persistent gaps in packaging, labeling, and chain-of-custody practices.

2 Battery quality and shipper behavior are the core drivers of risk.

Small and individual shippers (who may lack in-depth hazmat knowledge) commonly rely on carriers to catch errors, further reinforcing a pattern where responsibility shifts rather than settles. Uneven oversight and limited enforcement effectively push policing onto cargo airlines, leaving them responsible for mitigating risks they did not create and, in many cases, do not have the visibility to solve for.

3 Geography is a predictor of cargo risk.

With significant differences in manufacturing quality, regulatory oversight, and enforcement rigor across regions, a battery’s country of origin can be an indicator of a heightened threat. Just under half of known-origin incidents begin in a handful of Asian airports, reinforcing industry perceptions that geographic disparities amplify other risks such as battery quality, shipper behavior, and third-party involvement.

4 The system is built on trust — and just as equally on plausible deniability.

A complex supply chain allows for diffusion of accountability. Batteries pass through many hands: manufacturers, wholesalers, freight forwarders, consolidators, postal networks, third-party logistics providers, and airlines. Each link depends heavily on the previous one to comply. This creates a system built on trust, but also one built on plausible deniability. When safety issues emerge, the fragmentation offers every stakeholder a scapegoat further upstream or downstream. The complexity of the battery supply chain makes it difficult to pinpoint problems, let alone arrive at solutions.

Recommendations

Establish clear, enforceable responsibility across the supply chain.

All stakeholders must understand and uphold their specific roles in compliance, safety, and documentation. In a system where accountability is easily shifted, defining responsibilities — and enforcing consequences — is essential to reducing risk and closing the gaps that allow for plausible deniability.

Strengthen education and global industry coordination to reduce ambiguity and prevent errors.

Shippers — especially small and individual ones — need more guidance than airlines realize, and do not appear to be effectively accessing the guidance currently provided by regulators, cargo carriers, or e-commerce platforms. Coordination, data-sharing, and education can reduce confusion, misdeclaration, and reliance on trust alone.

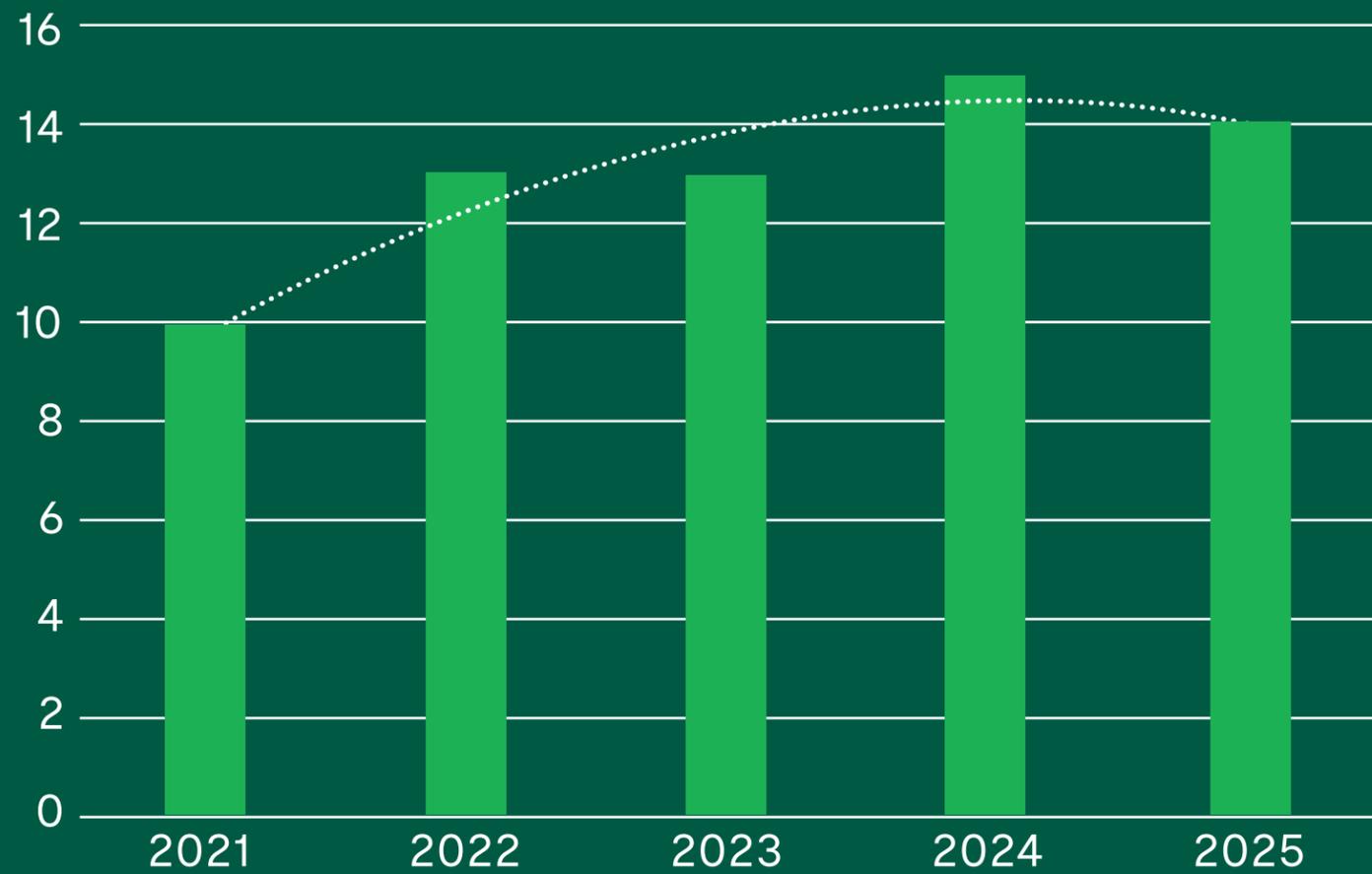
Treat safety and cost as aligned — not competing — priorities, and drive solutions from the top down.

Cutting corners on battery safety, packaging, or testing creates greater long-term financial, operational, and reputational risk. Regulators and global standards bodies must lead with uniform rules, training requirements, and enforcement structures that make safety the most economically rational choice. Shipping batteries that meet safety standards can reduce risk, as these batteries have proven to be safer and less prone to fire.

Related Resource:

IATA’s *From Origin to Destination: Ensuring Dangerous Goods Safety in the Cargo Supply Chain* report.

Thermal Runaway Incidents in Cargo, 2021-2025



Source: ULSE TRIP Database 02/04/2026 and FAA reports 01/28/2026

Rising Thermal Runaway Incidents in Cargo Aviation Amid Growing Demand for Batteries

Thermal runaway incidents in cargo aviation have risen over the past five years, with 65 events reported in TRIP between 2021 and 2025. Thermal runaway incidents in cargo aviation have increased by 40% from 2021 to 2025, and are increasing at an average yearly rate of 9%. These incidents highlight persistent safety challenges associated with the transport of lithium batteries by air.

While lithium batteries are regulated as dangerous goods, they differ from other hazardous materials in how they move through the supply chain. Lithium batteries, unlike many other dangerous goods, are embedded in consumer products and distributed through complex, often fragmented, global supply chains. Batteries vary widely in size, power, and quality, and fragmentation across the supply chain introduces greater variability in manufacturing, shipping, handling, and chain-of-custody practices.

Because of the possibility of thermal runaway, batteries shipped via aviation must conform to global standards for quality and for safe and robust packaging to prevent damage, as well as appropriate declaration and labeling as a dangerous good. However, regulators and manufacturers agree there is noncompliance across the supply chain, which they attribute to commercial pressures that prioritize speed and cost over safety.

- 65** Cargo incidents recorded in TRIP (2021-2025)
- 40%** Increase from 2021 to 2025
- 9%** Average annual growth



“ There’s so much demand for *MORE* and *MORE*. ”
 - Battery Manufacturer



The Core Drivers of Thermal Runaway Risk in Cargo

Stakeholders identified several factors that allow thermal runaway risk to enter the supply chain in cargo aviation; two factors, however, were most common in their responses:

Battery Quality

Including the quality of the original and subsequent manufacturers, validity of battery testing processes, and battery lifecycle.



Shipper Behavior

Including regulatory compliance, labeling and declaration, packaging, and involvement of third parties.

Nonconforming batteries — those not tested to an internationally recognized safety standard — are believed to introduce greater risk and are an outgrowth of consumer demand and commercial incentives. Nonconforming batteries may be appealing to consumers for various reasons including price, availability, and lack of consumer awareness of risk. ULSE surveys found that 60% of American adults do not realize that lithium-ion batteries power many of the devices they use every day, and another 50% admit to knowing nothing about them or the risks they pose.

All segments of industry — operators, regulators, battery manufacturers, and e-commerce stakeholders — raised concerns about the influx of nonconforming batteries in the supply chain. They agree that batteries that fail to meet required testing, packaging, and labeling requirements are dangerous to their interests, and to the general public, and they also believe that small-brand products are more likely to be of lower quality.



If you have poor quality, everything else down the road doesn't matter because *poor quality is always going to show its head.*

- Battery Manufacturer



There should be something that I have to put on the outside of the box to let them know what's inside, *but that has never been shown or taught to me.*

- Industry Shipper



The safe movement of lithium batteries through the global supply chain depends on an understanding of — and compliance with — complex global regulations. Cargo carriers must rely on shippers to understand and follow these requirements in order to move batteries safely.

However, stakeholders report that inadequate awareness and education among shippers, especially among small businesses and individuals, introduces significant risk, even when shippers intend to comply. Small and individual shippers often lack in-depth knowledge and may not recognize their shipments as dangerous goods — leading to errors and noncompliance such as mislabeling, improper packaging, and failure to provide proper documentation.

The perception of risk may also contribute to lower rates of concern. Compared to obvious dangerous goods like fireworks, ammunition, and gasoline, seemingly harmless common household products containing lithium batteries — like mobile phones, cordless vacuums, or portable chargers — may not be given the same level of thought, and consequently, care. One operator shared the



You've got people who might know, but don't know enough, so they're not properly trained, but even if you're properly trained, our regulations are really complicated.

I think there's deliberate noncompliance and innocent noncompliance.

- Industry Regulator



concern that at the post office, "people don't understand what's being asked...and they may not perceive lithium batteries as being hazmat." This wide variance of awareness and education among shippers, in addition to intentional noncompliance in the supply chain,

places the responsibility on carriers to distinguish between trustworthy shippers and those who might pose a higher risk.

Considering the risks from both unintentional noncompliance, as well as deliberate violations by those trying to take shortcuts, responsibility is shifted onto cargo carriers to catch mistakes and ensure safety. Yet carriers are unable to verify critical details, such as the state of charge in products being shipped, or to confirm what is inside a package beyond the exterior labeling and paperwork provided. As a result,

cargo carriers are left owning the risk without the technical ability to validate compliance — reinforcing a system in which responsibility shifts rather than settles.



"I think people... are not even aware that [batteries] can cause risks. There's some people who know and do it anyway. Those are the really bad people..."

- Industry Regulator

Geography Correlated to Cargo Risk



Thermal runaway risk in the battery supply chain is shaped by two primary factors: battery quality and shipper behavior. Across all stakeholder groups, geography emerged as the most frequently cited risk factor, influencing both battery quality and shipper practices. TRIP data reinforces industry beliefs that some regions are riskier than others when it comes to transporting batteries, with 42% of incidents from 2021 to 2025 (where origin and destination airport data are provided) originating from airports in Asia.

An enormous amount of cargo originates in Asia, so the likelihood of incidents beginning there can be attributed in part to volume. The International Air Transport Association found that the Asia Pacific region has a 35.9% share of the air cargo market. Lithium batteries, specifically, are produced predominantly in Asia. China alone accounts for nearly 85% of the world's battery cell production capacity, according to data from the International Energy Agency.

Beyond volume, however, geography is considered a risk factor because it is strongly associated with variations in manufacturing, product safety standards, regulatory oversight, and enforcement of regulations. These disparities are amplified by differences in industry practices, shipper training, and a lack of alignment across regions. Stakeholders expressed concern that bad actors exploit international variations, leveraging gaps in oversight and enforcement between regions to circumvent safety requirements and save on costs. Variations in the acceptance and enforcement of international product safety standards further compound these risks — creating vulnerabilities that ripple across the supply chain.

Ultimately, this issue is not about a single country or region, but rather a complex, commercially-driven system that allows for inconsistencies, confusion, and opportunistic noncompliance.

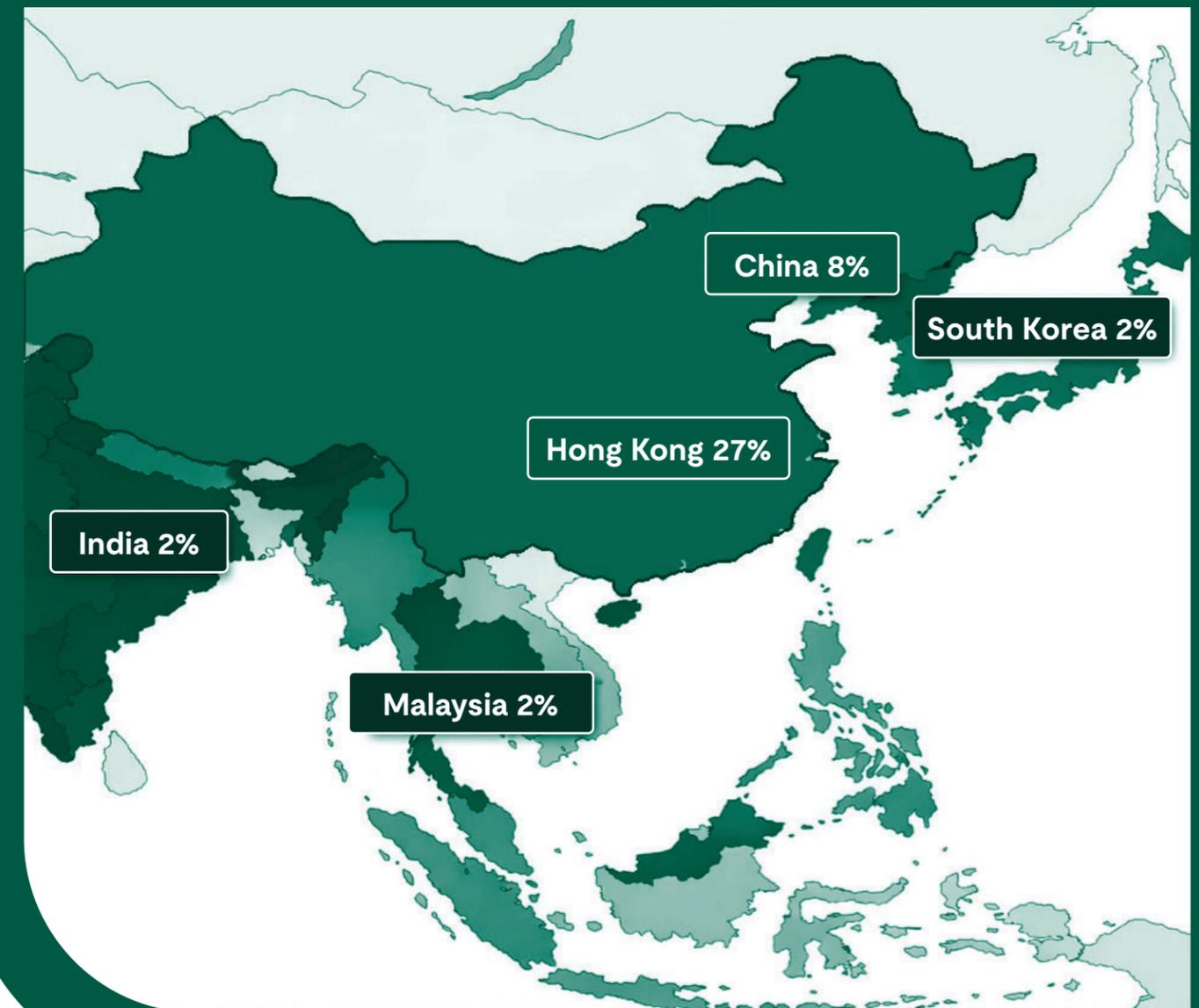
“ [In certain countries], you may see a little bit of a higher risks or opportunity for risk, because things are just different. The understanding of the test may be different. *The testing equipment may be even different. There's a lot of variations when you start shifting the landscape.* ”

- Air Cargo Operator

Where origin & destination airport information is provided (74% of events), shipments originating from *airports in Asia* were cited in 42% of the incidents:

- Hong Kong - 27%
- China - 8%
- South Korea - 2%
- Malaysia - 2%
- India - 2%

Thermal Runaway Incidents, Origin Airports 2021-2025



Source: ULSE TRIP Database 02/04/2026 and FAA reports 01/28/2026
Note - the origin does not necessarily represent the location of the incident.

A System Built on Trust and Plausible Deniability

The global lithium battery supply chain is complex and highly fragmented, with shipments often passing through multiple parties and/or modes of transport before reaching the end consumer. Consumer demand and cost pressures have driven the proliferation of third parties, often resulting in batteries being sourced from, as one operator described, “a wholesaler of a wholesaler of a wholesaler.” As the product moves further from its point of manufacture, oversight weakens and its testing validity is in question. Labeling and packaging errors can be introduced at multiple points, and batteries can be damaged in transit. While large manufacturers and shippers are commercially incentivized to prioritize safety and compliance for brand reputation, smaller players frequently prioritize cost, introducing significant risk.

The multimodal transport of lithium batteries compounds regulatory complexity as regulations differ across air, sea, and ground. Most shipments will encounter multiple modes of transport, creating opportunities for noncompliant shippers to unknowingly miss requirements or to intentionally exploit regulatory gaps.

With air cargo specifically, a substantial share moves on passenger aircraft. In the United States alone, approximately 25% of air cargo is carried on commercial passenger flights, and nearly all domestic commercial flights carry cargo. While bulk shipments of lithium batteries are prohibited on passenger aircraft, other

“ We don’t actually know the size of the problem when it comes to purported compliance [with required testing] versus those that actually comply. ”
– Regulatory Official

battery shipments are permitted, meaning upstream failures in declaration, packaging, or handling can translate directly into in-flight safety risks for passengers and crew. Of the 65 cargo incidents logged in the TRIP database, three occurred in passenger operations.

The lithium battery supply chain is not just complex; it is structured in a way that enables diffusion of accountability. This fragmentation, combined with regulatory inconsistencies and commercial incentives, creates a system in which trust is essential but insufficient. Industry stakeholders described oversight and enforcement as diffuse, with responsibility shared unevenly among regulators, airline carriers, and shippers. Without robust regulatory oversight and enforcement, the safe movement of lithium batteries through the global supply chain depends on shipper understanding of, and compliance with, complex global regulations. With no way to verify proper declaration and compliance, airlines feel particularly burdened with policing noncompliance. While regulators are expected to ensure safety, industry stakeholders viewed airline-led mitigations, such as shipper surveillance and training, as particularly critical in the current landscape.

Many airlines have developed their own approaches to identifying trustworthy shippers but often expressed frustration at being left holding the bag when regulators lack enforcement power. Regulators argue that enforcement is meant to work in partnership with carriers, yet acknowledged barriers to innovation in detection and suppression technologies.

When oversight fails, airlines resort to reactive measures based on their own risk assessments, leading to inconsistency across carriers. Common mitigations include fire-resistant containers, fire containment covers, thermal blankets, and battery containment bags. While these measures provide some assurance, they underscore the system’s reliance on trust rather than robust, uniform enforcement of regulations.

“ There’s a lot of trust... that everybody’s doing what they’re supposed to be doing. But I think with these consumer products, *the chances of things not being in compliance are greater* than they were for things like chemicals that we traditionally shipped by air. ”
– Regulator

“ Regulatory authorities are really relying on carriers... to do a lot of their policing and enforcement and investigation to try and identify shippers, reject shipments, even to bar... or refuse business from certain shippers ”
– Air Cargo Operator



Recommendations

Establish Clear, Enforceable Responsibility Across the Entire Supply Chain.

Lithium batteries pass through a complex network with multiple parties and/or modes of transport before reaching the end consumer. This fragmentation enables diffusion of accountability, as each link depends heavily on the previous one to comply, creating a system in which trust is essential but insufficient. Industry feedback underscores these challenges: regulators admit global rules are complex and open to interpretation, operators call for uniform standards and stricter enforcement, manufacturers argue complexity hinders compliance, and e-commerce platforms often exploit regulatory gray areas to maximize efficiency.

In an ideal state, responsibility would be shared across the supply chain, with each stakeholder actively contributing to risk reduction. Interviews and focus groups point to a coordinated model of responsibility: regulators lead with education and guidance; manufacturers strengthen internal compliance and risk-based advocacy; e-commerce platforms apply technology, oversight, and seller and shipper education; international associations convene and codify guidance; incident databases close the loop with actionable data.

Enforcing accountability at every stage will close gaps, eliminate ambiguity, and ensure all parties actively contribute to safety rather than deflecting blame.

Strengthen Education and Global Industry Coordination to Reduce Ambiguity and Prevent Errors.

Compliance varies widely across the system, with both unintentional gaps in awareness and intentional noncompliance driven by cost pressures among manufacturers, third-party intermediaries, and small/individual shippers. In this environment, cargo carriers are forced to rely on trust in their shippers to appropriately identify dangerous goods and meet documentation and packaging requirements — creating significant room for mistakes and noncompliance across multiple parties and modes of transport.

Industry stakeholders called for a coordinated, cross-industry approach to reduce confusion and reliance on trust alone. First, they suggested jointly developed and disseminated guidance tailored to different target groups like small shippers and third-party consolidators. While many airlines offer technical guidance and shipper education materials, stakeholders described a need for simplified general guidance that clearly explains technical requirements and is delivered at multiple touchpoints. Stakeholders also expressed a desire for a more coordinated and unified approach to oversight and enforcement with aligned and consistent checks across modes and ports, so that “who checks what, where” is clear and interoperable.

They also recommended the coordination of operational practices across the industry, including data sharing, shared visibility on shipper compliance, and aligned procedures for packaging and fire mitigation to create system-level assurance. The adoption of packaging procedures and fire mitigation strategies and devices that meet recognized standards may be leveraged to ensure a standardized approach that is proven to reduce risk.

Treat Safety and Cost as Aligned — Not Competing — Priorities, and Drive Solutions from the Top Down.

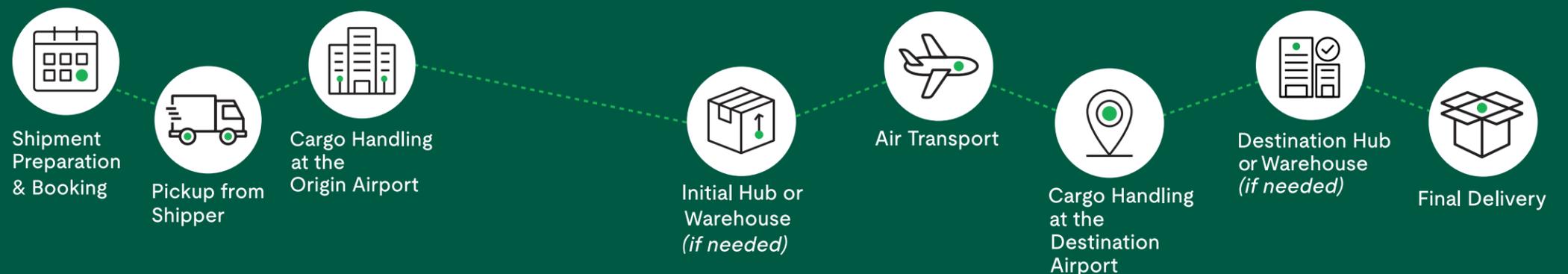
Cost pressures and consumer demand have fueled a complex and fragmented supply chain, weakening oversight and increasing opportunities for noncompliance that introduces risk. While large manufacturers and shippers are incentivized to prioritize compliance for brand reputation, smaller players admitted to cutting corners to save costs — introducing significant risk. These behaviors are enabled by regulatory differences across air, sea, and ground transport, and by global variations in shipping requirements, product safety standards, and enforcement, that can be taken advantage of.

Stakeholders agreed that the most durable solution would come from the top down: uniform rules, training requirements, and enforcement structures that make safety the most economically rational choice. Stakeholders suggested that coordinated rules, requirements, and enforcement across regions and modes of transport would bridge the gap between the safest choice and the most economically viable choice by making them one in the same.

The international adoption of product safety standards that help prevent the risk of thermal runaway is a critical step in eliminating the guesswork and risk in the supply chain. By aligning safety and cost, regulators and standards bodies can reduce long-term financial, operational, and reputational risk, while ensuring that compliant batteries are moved through the system with confidence.



Air Cargo Process Flow: Ideal State



Methodology

To develop a comprehensive portrait of lithium battery transport in the global supply chain, we combined qualitative insights from industry interviews and focus groups with incident data from the Thermal Runaway Incident Program (TRIP).

Qualitative Data Collection and Analysis

Cargo Industry Stakeholders:

ULSE held interviews (N=15) and focus groups (N=6) with international cargo industry stakeholders between June and July 2025. All interviews were recorded, transcribed, and analyzed using MAXQDA. A single-code frame guided thematic coding, resulting in 1,681 coded segments for analysis.

Small Shippers and Manufacturers:

ULSE partnered with Sago to recruit and conduct focus groups (N=11) and interviews (N=4) with small and individual US-based battery sellers and manufacturers between August and October 2025. Analysis was collaboratively performed by ULSE and Sago.

TRIP Incident Data

Cargo Incident Data:

This report analyzes cargo flight incident data from 2021-2025, drawn from TRIP- a voluntary reporting program capturing lithium battery thermal runaway incidents in aviation operations.

Data Constraints:

TRIP data reflects a subset of the airline industry, TRIP data reflects a subset of the airline industry, so findings cannot represent the full scope of global cargo operations. Additionally, the incident reporting process has inherent gaps because reports are generated by flight crews during safety-critical situations. As a result, details such as device ownership, damage characteristics, and root cause information are often incomplete due to limited forensic resources and operational priorities.

Quantitative Consumer Data

Survey results were primarily taken from a ULSE Insights U.S. consumer survey series of a cumulative 12,080 U.S. adults, conducted between January 2024 and November 2024. Surveys were designed and formulated by UL Standards & Engagement and administered online by BV Insights. The margin of sampling error at 95% confidence is +/-0.89%.





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