Standards & Engagement

Lithium-Ion Battery Incidents in Aviation: 2024 Data Review

Executive Summary

Rechargeable devices like phones, laptops, tablets, and portable power packs are integral to the air travel experience. The lithium-ion batteries that power these devices can, however, go into thermal runaway — a state of overheating that can result in fire or even explosion — if damaged, improperly charged, poorly manufactured, or counterfeit. At 35,000 feet, addressing such an incident becomes more complicated.

UL Standards & Engagement has been collecting thermal runaway incident data from airline partners and conducting surveys of the flying public to better understand the risks and the reality of thermal runaway in aviation. The data paints a more complete picture of the safety threat, opportunities to mitigate the risk, and how to contain issues if — and when — they happen.

The second annual look at findings from UL Standards & Engagement's Thermal Runaway Incident Program and analysis of U.S. passenger surveys show that the troubling trend of thermal runaway is still a significant safety threat — one that underscores the urgent reality of finding opportunities to achieve greater awareness and prevention.

Thermal runaway incidents on planes now average two per week

Key Takeaways

1. **Incidents are the second highest since 2019, averaging two per week.** With only seven fewer passenger incidents than 2023, 2024 showed the second highest rate of incidents in the consistent data collection of the last six years. However, the slight dip was not enough to change the weekly incident average. 2024, like 2023, saw an average of two thermal runaway incidents reported by airlines per week.
2. **Nearly 1 in 5 incidents result in significant passenger disruption (i.e. diverted landing, evacuation, return to gate).** The vast majority of thermal runaway incidents occurred on the aircraft (89% of incidents). Of those, 18% of incidents forced a diverted landing, return to gate, or emergency evacuation or unplanned deplaning.
3. **Vapes and power banks top the list of devices behind thermal runaway incidents in passenger air travel.** The average U.S. traveler brings four devices — most commonly smartphones (81%), laptops (40%), wireless headphones (38%), and tablets (35%). Vapes, while carried by only 10% of passengers, were still the leading cause of thermal runaway incidents, responsible for 28% of the reported total.
4. **Almost 2 in 5 passengers are packing rechargeable devices in checked luggage — where they can't be accessed during flight.** 38% of U.S. passengers admit to putting lithium-ion powered devices in their checked luggage. Another 30% of those who were asked to gate-check their carry-on bags were not asked about lithium-ion batteries in their luggage.
5. **Passengers are more worried about others' devices than their own.** 52% of U.S. travelers showed greater concern about the safety of other passengers' devices compared to their own (47%).

Reversing the Trend

With more lithium-ion battery-powered devices carried on board by passengers and flights operated returning to pre-pandemic levels, the corresponding increase in thermal runaway incidents is unsurprising.

Unsurprising does not mean acceptable. There are strategies to reduce the risk that will make a difference in passenger and crew safety across aviation:

1. **Passenger education:** ULSE surveys show an alarming lack of awareness and concerning behavior among U.S. airline passengers. Clear, repeated, and contextualized education on the issue will help passengers contribute to reducing the risk.
2. **Cabin crew training:** According to ULSE interviews and surveys with aviation professionals, all cabin crew are trained to respond to thermal runaway incidents on board an airplane. Training that is linked to available equipment, that is regularly evaluated and revised, and that replicates common, real-world scenarios will improve training that cabin crew receive.
3. **Standards for aircraft and baggage handling:** To help mitigate potentially catastrophic incidents, ULSE publishes standards that address the risks and hazards of thermal runaway. These standards include UL 5800, Battery Fire Containment Products; UL 5840, Electrical Systems of Battery Powered Aviation Ground Support Equipment; and the forthcoming UL 5810, Active Fire Protection for Air Cargo Containers.

Partnerships across industry, government, and other stakeholder groups are necessary to inform and implement all three recommendations. Diverse perspectives and experience will bolster collective efforts and help drive impactful change.

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Rechargeable devices — like phones, laptops, tablets, and portable power packs — are integral to the air travel experience. However, with wide and increasing usage of lithium-ion batteries in these and other consumer products comes an increase in the safety hazards they present.

If damaged, improperly charged, poorly manufactured, or counterfeit, these lithium-ion batteries can enter a process called thermal runaway, which occurs when the batteries overheat, posing serious risks that include fire or even explosion. Lithium-ion battery fires burn with intense speed and heat, which can potentially cause significant and widespread damage within seconds. They can also be more challenging to extinguish compared to fires involving other materials.

These risks are more complicated at 40,000 feet.

UL Standards & Engagement has been collecting thermal runaway incident data from airline partners and conducting surveys of the flying public to better understand the risks and the reality of thermal runaway in aviation. The data paints a more complete picture of the safety threat, opportunities to mitigate the risk, and how to contain issues if — and when — they happen.

The Thermal Runaway Incident Program

UL Standards & Engagement leads the Thermal Runaway Incident Program (TRIP), a voluntary reporting system designed for the aviation industry to better understand the extent of the problem and prepare for — or, ideally, prevent — future incidents.

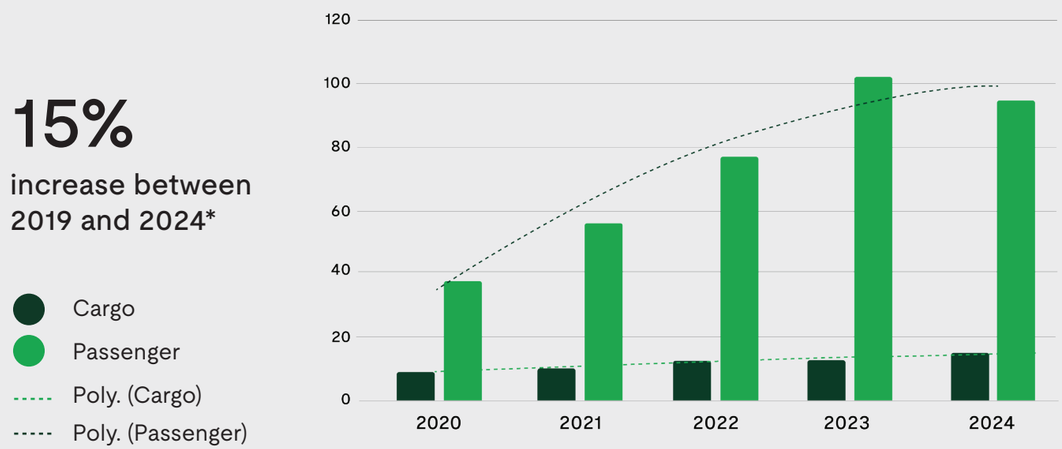
Participants from 37 passenger and cargo airlines provide detailed information on incidents within their operation. The information is anonymized and shared with aviation industry and safety organizations, offering insights to improve the safe transport and usage of lithium-ion battery-powered goods. The TRIP database operates as a surveillance tool, designed to capture data on the frequency, characteristics, and consequences of lithium-ion battery thermal runaway incidents in passenger and cargo operations.

At the end of 2024, the TRIP database contained a total of 942 incident records involving 75 air carriers and the U.S. Transportation Security Administration. These incident records date back to 2006, when a counterfeit battery in a flashlight went into thermal runaway on a cargo flight.

This report specifically analyzes the data from passenger flight incidents in 2024.

15%

increase between 2019 and 2024*



Incident count, 2020 compared to 2024 | Source: ULSE TRIP Database, participant and FAA reports, as of 2024-12-31

*96 total incidents in 2019

Thermal Runaway Incident Rates and Trends

In 2024, an average of two flights per week experienced a thermal runaway incident. This mirrors the 2023 average, though there was a slight dip in the total number of reported passenger flight incidents, with seven fewer in 2024.

> *The marginal drop still makes the 2024 incident total the second highest since 2019 by 11 incidents.*

Similar data from the Federal Aviation Administration shows an increase in the number of lithium-ion battery fires in 2024: 12 more incidents than in 2023, a 16% increase. TRIP and FAA data sets include slightly different inputs. FAA data is taken from mandatory federal reporting, while TRIP includes additional reports from every stage of the travel process by factoring in incidents in the terminal, bag checking, security checkpoints, and leaving baggage claim.

Apart from the obvious danger of a thermal runaway incident, TRIP data reveals that 18% of passenger flights that experience an on-board incident result in a diverted landing, return to the gate, emergency evacuation, or unplanned deplaning. These outcomes mean substantial disruptions, delays, or even cancellations that inconvenience travelers.

TRIP data reveals that 18% of passenger flights that experience an incident result in significant passenger disruption, like a diverted landing or passenger evacuation.

Device	Responsibility for Incidents in TRIP Database	Percentage of Passengers Bringing on Board
Vape or e-cigarette	28%	10%
Power bank	19%	29%
Cell phone	18%	81%
Laptop	15%	40%

The Leading Devices Behind Thermal Runaway Incidents

Nearly all airline passengers (96%) typically bring at least one rechargeable product containing lithium-ion batteries on board. The average traveler brings four devices — most commonly smartphones (81%), laptops (40%), wireless headphones (38%), and tablets (35%). Twenty-nine percent bring a portable charger or power bank with them, while 10% travel with an e-cigarette or vaping device.

Among the common types of devices carried on board by passengers, some are more significant contributors to thermal runaway incidents than others. E-cigarettes or vapes were responsible for the most incidents in 2024, with 28% of reported incidents attributed to these devices on passenger flights.

Given that only 10% of passengers say they travel with an e-cigarette or vaping device, the outsized impact is notable and shows how prone vape batteries are to thermal runaway. A U.S. Fire Administration report on e-cigarettes stated,

> "The shape and construction of electronic cigarettes can make them (more likely than other products with lithium-ion batteries) behave like 'flaming rockets' when a battery fails."

Power banks are the second most likely culprit, representing another 19% of passenger flight incidents. Despite causing less than 1 in 5 incidents, power banks were behind some of the most visible recent news stories about thermal runaway in aviation. In January 2025, a passenger's power bank in the overhead bin of an Air Busan flight from South Korea caused catastrophic damage to the aircraft. Fortunately, all passengers and crew escaped, but images of the burned plane were widely circulated.

Rounding out the top four products cited in the TRIP database, cell phones were behind 18% of incidents and laptops accounted for 15% of incidents. Both cell phones and laptops were at their highest number since TRIP was established.

What Do Passengers Know About Lithium-Ion Batteries?

As more types of products adopt lithium-ion battery technology, they become more difficult to identify. The 2024 TRIP data showed a continued proliferation of the types of devices behind incidents. While they may not be reaching the same percentages as vapes, power banks, and cell phones, the growing usage of lithium-ion batteries in a variety of rechargeable products has brought items onto planes such as flashlights, a medical refrigerator, a point-of-sale device, and a neck fan. Cabin crew interviewed by ULSE have reported seeing everything from children's toys to travel blenders to battery-assisted strollers.

Despite the prevalence of lithium-ion battery-powered devices, half (50%) of Americans admit to knowing nothing about these batteries, up from 44% who said the same in an earlier report. Further, 3 in 5 consumers (60%) are unaware that lithium-ion batteries power many of the products they routinely use. These knowledge gaps have serious implications for aviation safety.

When exposed to information about thermal runaway and the potential safety risks, travelers showed greater concern about the safety of other passengers' devices compared to theirs: 52% of respondents say they are concerned about the devices belonging to other passengers overheating; 47% are concerned about their own.

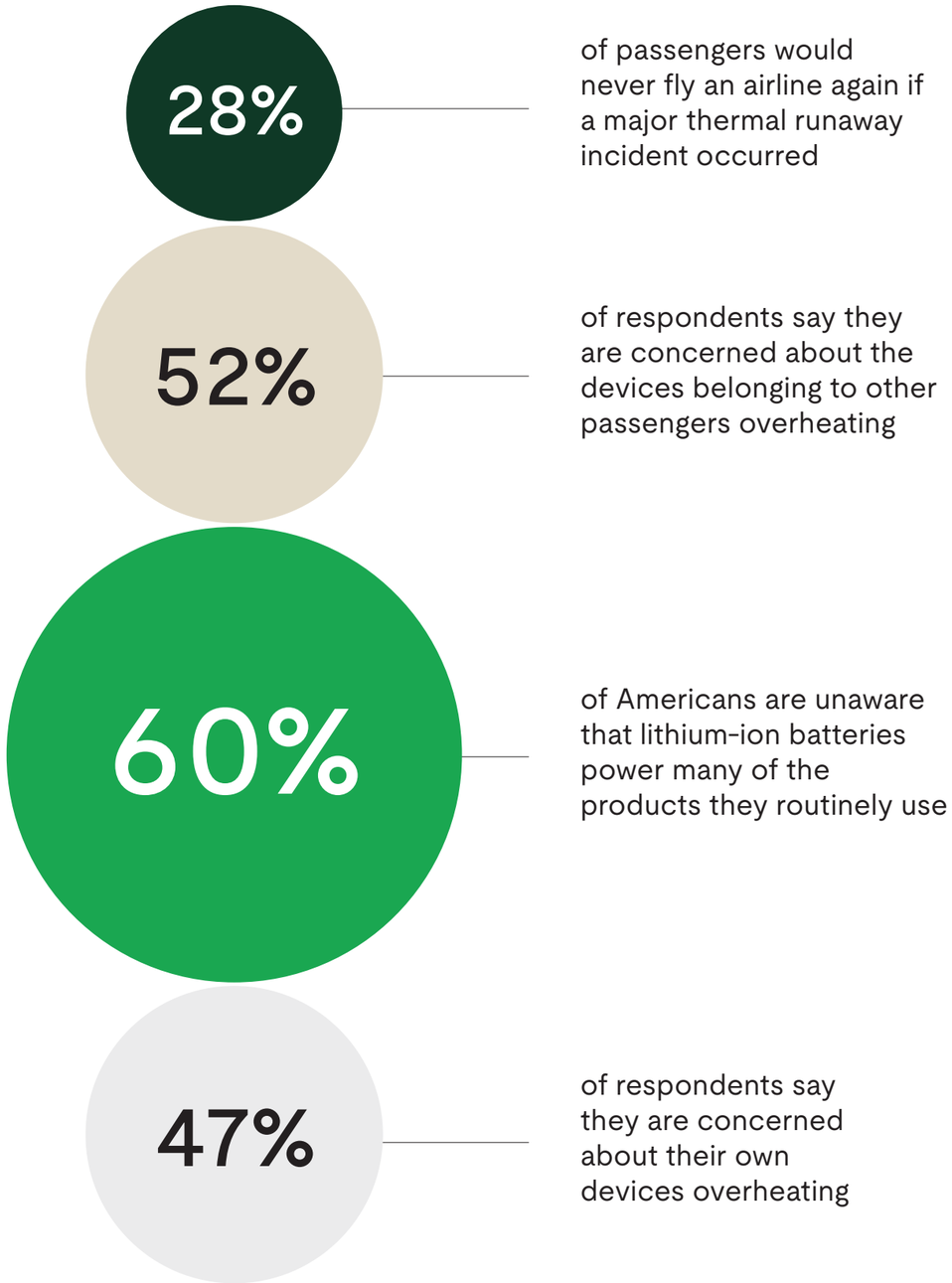
50%
of Americans admit to knowing nothing about lithium-ion batteries

The unfortunate upward trend of thermal runaway incidents may lead to eroding passenger confidence. Passengers surveyed said that a major thermal runaway incident (i.e., device catching fire) would lead 46% to avoid traveling with an airline and 28% to never fly that airline again. Moderate incidents (i.e., visible smoke from a device) would cause 47% to avoid the airline with 18% saying they would not fly the airline again. Even minor incidents (i.e., a device overheating) would lead 33% of travelers to avoid the airline and 14% to never fly it again.

Despite the strong pull to avoid or stop flying an airline in the wake of a thermal runaway incident, many travelers still underestimate the threat their devices pose on airplanes and engage in behaviors that run counter to best practices — especially when it comes to where they are packing them.

The average traveler brings four lithium-ion devices on board

Passenger Views on Lithium-Ion Battery Safety



Packing Practices Reveal Troubling Behavior

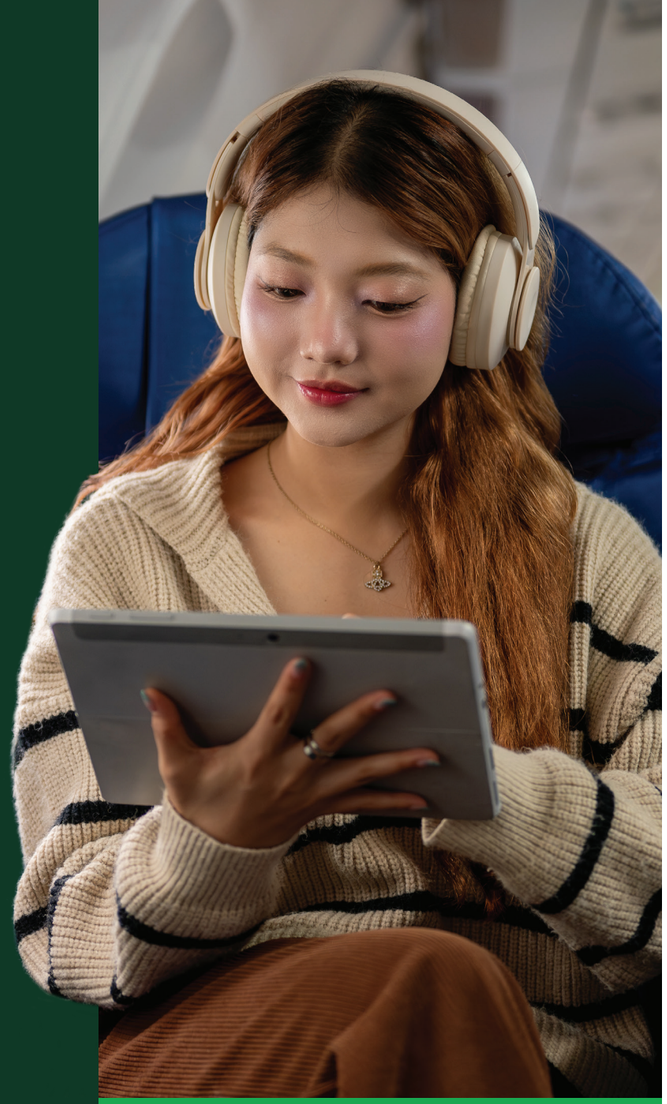
Lithium-ion battery-powered devices should never be packed in checked baggage. Keeping these products at arm's reach in the cabin provides better ability to handle thermal runaway incidents before they become a bigger threat.

Unfortunately, many passengers do not follow this critical practice — likely because they do not know they should. Airlines warn travelers about lithium-ion batteries; however, these warnings often go unseen and unheard. When asked about what they recall seeing and hearing about lithium-ion batteries, 51% of airline travelers are either unsure or did not see any signage or hear announcements about lithium-ion batteries during their travels.

The lack of awareness translates to rechargeable products that are often out of reach. Approximately 2 in 5 (38%) passengers admit to putting lithium-ion powered products in their checked luggage.

Despite the dangers of having devices powered by lithium-ion batteries in checked luggage, it continues to occur. Airlines participating in TRIP have shared that TSA removes many laptops, cell phones, and other personal electronic devices from checked bags due to swollen batteries or other damage. However, devices that do not show these types of outward signs of damage are not currently being removed.

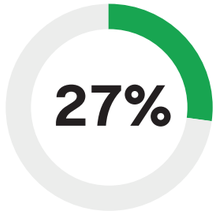
Devices that enter thermal runaway in checked baggage cannot be accessed by crew while in-flight, and fires may not be detected as quickly in the cargo hold as they would be in the cabin. When a fire is detected in the cargo hold, there are limited options to fight it — typically through means such as halon extinguishers and oxygen-depriving systems. However, these methods may not be effective on lithium-ion battery fires due to the nature of thermal runaway, which makes them difficult to extinguish and increases the likelihood of reignition.



Approximately 2 in 5 (38%) passengers admit to putting lithium-ion powered products in their checked luggage

Where Passengers Are Packing Rechargeable Devices

	Smartphone	Laptop	Tablet	Portable Charger	E-Cigarettes
At my seat	92%	54%	64%	44%	51%
Overhead compartment	4%	29%	20%	29%	18%
In checked luggage	4%	18%	16%	27%	31%



of the time portable chargers are in checked luggage

The two types of devices most commonly involved in thermal runaway incidents are often packed in checked luggage or the overhead compartment — where it also takes longer to notice and manage an issue. Vapes or e-cigarettes are put in checked luggage 31% of the time, and in the overhead bin 18% of the time. Portable chargers are in checked luggage 27% of the time and in the overhead compartment 29% of the time.

Luggage intended for the overhead bin, however, does not always end up there. With full compartments and plane sizes, baggage that passengers planned to have with them is frequently gate-checked and put under the plane. In these cases, 30% of passengers say they were not asked about lithium-ion batteries in their luggage. The ability to repack or rearrange at the gate is also limited, which may lead passengers to leave potentially dangerous items in gate-checked bags.

Where Incidents Happen and How to Educate Passengers

TRIP data shows that in 20% of passenger flight incidents during 2024, the battery or device was stored in a bag, backpack, or purse. Thirty percent of the time, data for device usage wasn't available. In 21% of incidents, the device was carried or held by the person but was not in use; 20% of the incidents occurred while the device was in use. Notably, only one reported incident (1%) involved charging the battery or device using the aircraft's USB or AC outlets.

Thermal runaway incidents that occur on the aircraft happen in or around the passenger's seat 86% of the time, which can result in quicker corrective action during a thermal runaway event. The majority (70%) of passenger incidents in 2024 were addressed when batteries showed warning signs such as overheating and smoking prior to entering full thermal runaway. These were contained with some type of thermal runaway containment equipment.

While only 18% of incidents resulted in fire or explosion, complacency to the risk is not advisable. The speed at which thermal runaway can intensify means that within seconds the other events could have been more serious.

Passenger education can significantly reduce the threat of thermal runaway. Communicating best practices on how and where to pack rechargeable devices needs to be shared before passengers arrive at the airport. Forty-two percent would prefer to receive lithium-ion battery safety information during booking, another 34% favor email — ideally through some simple dos and don'ts. This type of straightforward guidance would be most effective, according to 87% of passengers.

Clarity also matters. A large majority (80%) of passengers want airlines to clearly communicate lithium-ion battery safety measures. But as a flight attendant interviewed by ULSE last year clarified, "We make an announcement that if you drop your device in a seat, do not move your seat… but they don't say because it could catch on fire." She added, "We're giving them small pieces of data without any context."

From Check-In to Baggage Claim: When Incidents Occur

As noted earlier, TRIP data covers the continuum of air travel — from when passengers walk into the airport to baggage claim pickup at the end of their journey. The vast majority (89%) of incidents from 2024 were reported on the aircraft, with the remaining 11% involving checked baggage and items carried by passengers. The incidents happening on the aircraft ticked up slightly from 87% in 2023 data.

Any thermal runaway incident on an aircraft is a serious safety concern, but the risk increases while the plane is in the air. More than half (52%) of incidents occurred during the cruising phase. Another 15% of incidents occurred during critical phases of flight (takeoff, climb, descent, final approach, and landing). During these phases, the risk is inherently higher, in part because the pilots are engaged in these important activities and cannot assist. Furthermore, passengers cannot evacuate and the ability to clear the area where an incident is occurring is hampered, unsafe, or not possible.

In 2024, 5% of thermal runaway incidents occurred during the handling of checked baggage — defined as the entire chain of events between a passenger turning over a bag to the airline and the passenger retrieving the bag at baggage claim. That is a decline from the 2023 data, in which 12% of incidents occurred in the baggage handling chain, but there was at least one incident at every step of the baggage handling process, except baggage claim.

One goal of the TRIP program is to determine the causes of thermal runaway incidents in the aviation space. Some causes are clear, such as a short-circuiting battery or device due to severe damage from handling or use. Other causes are less obvious, so data about what preceded the thermal runaway incident is captured (if known), including how the device was used.

Unfortunately, in 77% of incidents, no presumed cause of the event is provided in the reports submitted by flight crews. When this information is collected, the most common preceding event is that the device or battery was crushed or compressed. Airlines are increasingly including in their safety announcements a request that passengers notify the cabin crew if their mobile phones fall between their seats, instead of trying to retrieve the devices themselves.

> It was the product's power source — a lithium-ion battery — that was the suspected cause of the fire

What Should Be Learned in the Aftermath of the Air Busan Fire

A recent spate of thermal runaway incidents is making the issue more visible to the traveling public. An Air France plane bound for the Caribbean was recently forced to turn around mid-flight after a passenger dropped a phone. A Hawaiian Air flight was forced to make an emergency landing in Japan. In May, a Southwest flight was forced to return to the gate in El Paso after a passenger's phone caught fire.

One of aviation's scariest battery fire incidents in recent years occurred in January when a suspected power bank — the kind that 29% of U.S. flyers are traveling with — went into thermal runaway, causing catastrophic damage to an Air Busan plane in South Korea.

The power bank was compressed in the overhead bin and caught fire. Fortunately for the 169 passengers and seven crew members on board, the plane was still awaiting takeoff when the flames tore through the aircraft and everyone was able to escape. The plane was a total loss.

The incident earned the attention and scrutiny of the aviation community and international media. As the news turned to coverage of the steps airlines in Asia are taking to help prevent another incident such as the one on Air Busan, a clear trend emerged: all the enforcement action was aimed at power banks. While no airlines have banned passengers from bringing power banks, aside from batteries greater than 100-160 watt-hours, most have cracked down on what is allowed during flight.

This product-specific action, however, is too narrow of a lens. It was the product's power source — a lithium-ion battery — that was the suspected cause of the fire.

The aftermath of the damage to the Air Busan flight is visually alarming. It is also a warning not to wait to make changes that will improve safety in the air.

Mayor of Busan Park Heong-joon and other officials visit the site where an Air Busan airplane caught fire at Gimhae International Airport in Busan, South Korea, Wednesday, Jan. 29, 2025. (Son Hyung-joo/Yonhap via AP)

How to Reverse the Trend

With more lithium-ion battery-powered devices carried on board by passengers — and the number of travelers having returned to pre-pandemic levels — the corresponding increase in thermal runaway incidents is unsurprising. Unsurprising does not mean acceptable.

Strategies to reduce the risk emerge via TRIP, active participation of the aviation community, and additional insights and analysis from ULSE's surveys, interviews, and focus groups. Three areas of opportunity surfaced:

1. Passenger education
2. Cabin crew training
3. Standards for equipment on board and baggage handling

Passenger Education

Passengers may not know about best practices for packing and handling lithium-ion battery-powered devices. Education can make a difference.

Expanded passenger education initiatives could include raising awareness about only using lithium-ion battery-powered devices and accessories that are certified to meet applicable safety standards. The safeguards in standards are intended to mitigate various hazards — including thermal runaway.

Both frequent and infrequent fliers reported that in order to change their behavior, they would like to receive information reinforcing the message about how to pack these devices in different ways and with greater frequency than they do currently. Successful passenger awareness efforts must be clear, consistent, and present at multiple points before and during the passenger's journey to raise awareness and result in behavioral change. Nearly 9 in 10 (87%) passengers say they would want simple dos and don'ts.

A simple don't from the Transportation Security Agency's recently issued guidance: do not put portable chargers in checked luggage. Not following the updated guidance could result in losing expedited security programs like TSA PreCheck or civil penalties of up to $17,062 per person.

Cabin Crew Procedures and Training

All cabin crew are trained to respond to thermal runaway incidents on board an airplane. Procedures vary across airlines according to the layout of the plane, number of crew on board, and available safety equipment such as fire extinguishers, containment bags, and personal protective equipment.

Cabin crew self-identified gaps in their understanding of thermal runaway events and the appropriate order of operations when addressing these fires. The recommendations that emerged through ULSE's conversations with cabin crew include the following:

- Training design and procedures should be closely linked to available equipment
- Planes should be equipped with the appropriate equipment in the correct locations
- Training should be evaluated and revised based on emerging risks
- Training should replicate common, real-world scenarios, such as a device becoming overheated in an overhead bin or between the seats, or a fire occurring during the critical phases of a flight

Standards for Equipment on Board and Baggage Handling

To help address these potentially catastrophic incidents, containment products have been developed and marketed to airlines. These products are typically bags, large enough to hold a laptop computer, which are designed to suppress the flames, smoke, and off-gassing from lithium-ion battery fires. The FAA does not currently require airlines to have this equipment on aircraft, but some airlines have taken the initiative to stock their fleets.

Efficacy and ease of use are essential to mitigating battery fires using these products. As a result, ULSE was approached by aviation industry representatives to develop a safety standard for them. The collective effort resulted in UL 5800, Battery Fire Containment Products, first published in 2020. In-scope containment products are intended for use in the aircraft's passenger cabin or cockpit by authorized personnel for lithium-ion battery-powered portable electronic devices that are entering or have entered thermal runaway.

ULSE is currently working with a technical committee and other stakeholders on the development of UL 5810, Active Fire Protection for Air Cargo Containers, to help address lithium-ion battery-related hazards in cargo settings. Additionally, UL 5840, Electrical Systems of Battery Powered Aviation Ground Support Equipment, was published in 2022 to help address hazards related to ground support equipment operating around aircraft.

Methodology

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. As a member of the Insights Association and ESOMAR (the European Society for Opinion and Marketing Research), BV Insights adheres to industry ethics and best practices, including maintaining the anonymity of respondents.

The margin of sampling error at 95% confidence for aggregate results is +/- 0.89%. Sampling error is larger for subgroups of the data. As with any survey, sampling error is only one source of possible error. While non-sampling error cannot be accurately calculated, precautionary steps were taken in all phases of the survey design and the collection and processing of the data to minimize its influence.

ULSE held seven in-depth interviews (n=7) and six focus groups (n=4) focused on cabin crew experienced and preparation for a total of n=48 participating flight crew members. All focus group data was transcribed, uploaded into the MAXQDA software platform, and analyzed with a hybrid coding frame.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