

Turbulence Injury Mitigation

BACKGROUND

Recent annual safety reports have shown a significant rise in the number of turbulence events worldwide that resulted in injuries, such as bone fracture, to crews and passengers. At the 14th ICAO Air Navigation Conference, Working Papers [WP-98](#) (presented by Japan and Singapore, co-sponsored by Philippines, Thailand, ACI and IATA), and [WP-149](#) (presented by South Korea), both expressed concerns that turbulence encounters are a global operational safety risk, and proposed to improve turbulence related risk monitoring by collecting, analysing, and utilizing turbulence data.

These WPs emphasized the need for turbulence-related information sharing and sought ICAO's support and promotion of international cooperation for effective turbulence risk management. In 2021, the NTSB published a [Safety Research Report](#) with their findings and recommendations on turbulence injury mitigation. An [article](#) on "managing turbulence" was also published on EASA's website, with a set of recommendations.

New initiatives are regularly underway to address the risk, such as the recent [IATA Turbulence Aware Platform](#), designed to provide better situational awareness on potential turbulence areas through the automated sharing of turbulence data and reports at different altitudes. ICAO has also published a [Turbulence Toolkit](#), with several helpful links to government and industry recommendations¹.

This Briefing Leaflet seeks to emphasize awareness of turbulence related injuries and share methods of avoidance and mitigation.

TYPES OF TURBULENCE

The 2024 edition of the ICAO Annual Safety Report cites turbulence encounters as the leading occurrence category for accidents in 2023². Turbulence encounters are one of the most difficult weather phenomena to predict and can significantly impact the safety of the flight. Some degree of turbulence is present on almost every flight, regardless of the type or size of the aircraft, and can never be completely avoided.

¹ ICAO, [Turbulence Toolkit](#)

² ICAO Safety Report, (2024)

Turbulence is typically categorized by its source, such as convection, clear air, mountain waves, wind deflection by surface features and wake vortices. The NTSB published a Safety Research Report in 2021, in which a review of accident data indicated turbulence due to convective activity accounts for more than half of the injuries (57%), while Clear Air Turbulence (CAT) is the next largest contributor (28%). Understandably, intensity data indicates that severe (44%) and moderate (41%) turbulence account for the largest percentage of injuries³.

The Flight Safety Foundation's 2024 [Safety Report](#) also underscores this concern, noting that turbulence encounters have been the most frequent accident category worldwide for the past three years, with 2024 recording the highest number of turbulence-related accidents in one year since 1982.

While turbulence is difficult to predict, it is known to be associated with convective activity which is indicated by the presence of thunderstorms and/or cumulonimbus clouds. An accepted strategy for mitigating this risk is to laterally deviate around thunderstorms or convective weather as identified visually, by onboard radar or other available means.⁴

Weather is not an exact science, and the actual severity of turbulence is often difficult to predict and assess, even with the latest onboard technology. In July 2024, Airbus published an [article](#) highlighting this, also recalling that "*...compliance with safety protocols, such as the wearing of seatbelts, reduces the risk of injury and ensures the safety and comfort of all passengers.*"

TURBULENCE-RELATED INJURIES

The potential for injuries due to turbulence is an issue that is well recognized within the aviation industry. The dynamic consequences of severe turbulence should not be underestimated. Aviation experts and safety officials consistently stress the importance of wearing seatbelts while seated.

An NTSB study of US airline accidents due to turbulence from 2009 to 2018 indicates that only 1 of the 123 passengers with severe injuries was documented as wearing a seatbelt.⁵ Even mild turbulence can lead to injuries, making it essential for passengers to

³NTSB Safety Research Report, Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121 (August 2021)

⁴ CAST JSAT (2001) ; AC-120-88A; Airbus (2024) ; EASA (2024)

⁵ NTSB Safety Research Report : Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121 (August 2021)

keep their seatbelt fastened at all times while seated to protect themselves from unexpected turbulence.

In the most severe cases, passengers who do not wear their seatbelts can be thrown from their seat resulting in serious injuries. It can also become more difficult to fasten a seatbelt once a severe turbulence event has started.

Though it may be necessary to unfasten seatbelts briefly during the flight, for example for restroom use or stretching, minimizing these instances and remaining seated whenever possible is crucial. Passengers play a vital role in ensuring their own safety and that of others by adhering to crew instructions and following established safety protocols.

The NTSB indicates that among U.S. air carriers, more than one-third of all accidents are the result of injuries due to turbulence, making it the most common type of accident among air carriers. Studies of accident data from 1989-2018 indicate that flight attendants are 24 times more likely to be injured than passengers and account for roughly 78% of those injured from turbulence.

Available data from these events indicate that most injuries (60%) occurred during descent below 20,000 feet and in the aft area of the airplane with 88% of flight attendant injuries and 82% of passenger injuries occurring there.⁶ While there may be several factors involved, it is likely that many of these injuries are due to people waiting or walking near the aft lavatories, or similarly, flight attendants conducting their duties in the aisle or aft galley.

FLIGHT PLANNING

Adopting a culture of avoiding turbulence is the first line of defense. During preflight planning, all available resources should be used to plan around convective activity, thereby avoiding associated turbulence. Products incorporating radar and total lightning data make these areas somewhat more identifiable and accurate to forecast. However, CAT, commonly encountered at high altitudes in cloudless skies, presents a unique challenge. Since it is not associated with visible clouds, clear air turbulence is more difficult to identify and plan for.

Turbulence avoidance should continue on a tactical basis enroute. All resources should be used, including EFB access to inflight internet to obtain near real-time updates. Using separation standards from convective weather referencing visual cues or onboard

⁶ NTSB, (August 2021)

systems such as radar can provide a margin for turbulence avoidance. While traditional PIREPs might lack fidelity and timeliness, ATC often has information for their sector of airspace about turbulence as reported by pilots that is more accurate and timelier.

When checking-in on a new frequency, it can be useful for pilots to report current conditions, including smooth air, and ask for information on turbulence. Controllers understand where the areas of turbulence are, and which altitudes are affected based on reports and requested deviations. Similarly, reporting turbulence on common frequencies and to dispatch can provide very useful information on the latest conditions for flights following or being planned.⁷

CABIN CREW AND PASSENGER BRIEFING

Briefing the cabin crew and passengers on turbulence should also be part of the preflight planning.

Cabin crew are the most likely to be injured in turbulence. A preflight briefing of when to expect moderate or greater turbulence as forecasted along the flight, as well as prompt and clear communication of turbulence advisories in flight is important to their safety. Using standard, agreed-upon phraseology to give notice in advance of turbulence gives them time to secure the cabin and be seated with seatbelts fastened.⁸

Accident data indicates that most cabin crew injuries during descent occur below 20,000.⁹ When conditions indicate a probability of moderate or greater turbulence, it is recommended to brief the cabin crew to complete their duties and secure the cabin prior to this point.¹⁰

The seatbelt sign should only be switched off during cruise, when turbulence is not forecast, experienced, or anticipated, to indicate that services may continue and that passengers may release their seatbelts temporarily to visit the lavatory or for short physiological breaks.

When briefing passengers as to the expected turbulence in a preflight announcement, a statement should be included about remaining seated with seatbelts fastened, regardless of the status of the seatbelt sign. Providing timely updates and advanced warning, when possible, of turbulence and fasten seatbelt sign illumination encourages compliance in keeping seatbelts fastened at all times, rather than mere reliance on the

⁷ CAST, JAST/JSIT

⁸ CAST, JSAT (2001); FAA, AC 120-88A (2007)

⁹ NTSB, (2021)

¹⁰ CAST, JSAT (2001)

seatbelt sign alone. Prompt and clear PA announcements from the flight crew tend to carry more emphasis than those from the cabin crew, and when conducted, appropriately emphasize the requirement to comply with the fasten seatbelt sign.¹¹

CONCLUSION

Injuries due to turbulence account for the highest percentage of commercial airliner accidents. While turbulence can never be entirely avoided, there are recommended mitigations, the best way to prevent injuries is to advise the passengers to keep their seatbelts fastened at all times, regardless of the illumination of the “fasten seatbelt sign”.

At flight planning stage, a strategy of avoidance also helps to prevent the potential for injury. During the flight, the use of onboard radar, reports of turbulence, or internet enabled weather are great tools for tactical airborne decision making to avoid areas of probable turbulence.

Communication is a key part to preparing for turbulence. Setting expectations of forecasted turbulence to cabin crew and passengers, followed by tactical announcements using agreed phraseology, makes a difference in securing and preparing for turbulence encounters.

Mitigating injuries from turbulence should be a collaborative effort that involves all relevant stakeholders, including States, International Organizations and the global aviation industry.

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¹¹ CAST, JSAT (2001); NTSB (2021)