



Staying Safe against In-flight Turbulence

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What is turbulence?

High in the sky, as you are cruising to your destination, the seat belt sign goes on. As you look out the window, there are no clouds for kilometres. What could you possibly run into at this height? Turbulence – a frequently invisible problem for aircraft.

Figure 1: Where's the turbulence?



Photo courtesy of Core Lohse

Turbulence is a weather phenomenon responsible for the abrupt sideways and vertical jolts that passengers often experience during flights, and is the leading cause of in-flight injuries to passengers and cabin crew.

Turbulence is caused by the irregular movement of air, and often cannot be seen. When air masses with different speeds, direction or temperatures meet each other – such as a warm or cold front, a thunderstorm, air flowing over or around mountains, or near jet streams – turbulence is likely to occur.

How serious is turbulence?

While turbulence is normal and occurs frequently, it can be dangerous. Turbulence by its nature is unpredictable – occurring without warning, and ranging from a few minor bumps to a major shake-up.

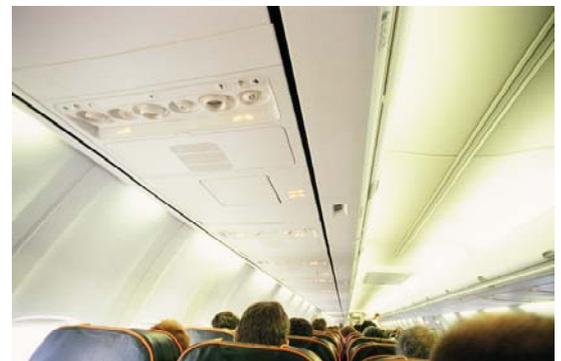
Aircraft can handle even severe turbulence, and are designed to flex with the bumps and jolts. Turbulence is usually more severe in the cabin than in the cockpit.

Turbulence is rarely a threat to passenger aircraft or to pilot control of the aircraft.

So why do you need to be prepared for turbulence? While your aircraft is designed to take turbulence, your body is not.

In a typical turbulence incident, 99% of people on board receive no injuries. However, the bumpy ride can cause passengers and cabin crew who are not wearing their seat belts to be thrown around without warning. About a dozen in-flight turbulence injuries are reported in Australia each year to the Australian Transport Safety Bureau (ATSB), and many more go unreported. Some of these injuries are serious, and have resulted in broken bones and head injuries.

Figure 2: Unrestrained passengers can sustain head injuries during turbulence by hitting overhead panels



An ATSB report found that passengers being thrown up and out of their seat during turbulence was the **second most common** type of head injury on aircraft.

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Between January 1998 and May 2008, there were 339 turbulence occurrences in Australia reported by airlines to the ATSB. These resulted in over 150 minor and serious injuries to passengers and cabin crew. The United States Federal Aviation Administration (FAA) estimates that the cost to the worldwide aviation industry of turbulence injuries is over US\$100 million annually, and growing.

If you travel by air, you need to take turbulence seriously.

Bumpy approach

In 2000, a 60-seat turboprop aircraft encountered severe turbulence on approach to Sydney.

One of the passengers attempted to tighten her seatbelt but inadvertently released it. As a result, she was thrown up out of her seat and struck her head on the overhead cabin fittings.

She suffered minor injuries, and was treated by ambulance staff when the aircraft landed.

Figure 3: Turbulence can affect aircraft of all sizes



Common types of turbulence

Thunderstorm turbulence

The Civil Aviation Safety Authority (CASA) requires pilots to avoid flying near storms and other sources of serious turbulence. Thunderstorm turbulence is displayed to pilots via on-board radar, making it avoidable.

Mountain wave turbulence

When air blows over a mountain range, it causes a series of turbulent updrafts and downdrafts.

Aircraft wake vortex turbulence

As objects move through the air, they disturb the air and generate vortices known as wake turbulence. To prevent wake turbulence affecting other aircraft, Airservices Australia apply wake vortex separation distances between aircraft.

Clear air turbulence (CAT)

Clear air turbulence (CAT) is the main culprit in surprise turbulence.

CAT strikes out of the blue, in dry clear air. CAT is particularly serious because:

- It is hard for pilots, air traffic control and weather forecasters to detect – so there is often no warning until you fly into it.
- It can occur when no clouds are visible.
- It can't be detected by aircraft radar.
- It is common at the high altitudes which airliners cruise at, especially in the vicinity of jet streams.

All types of in-flight turbulence usually last for no more than a few minutes.

Clear air surprise

In 2000, a Boeing 747-400 encountered clear air turbulence (CAT) en route from Sydney to Osaka, Japan. Although the weather forecast indicated thunderstorms within 200 km of the aircraft's route, no turbulence was forecast.

When the CAT struck, the seat belt sign was not illuminated, and people were moving about the cabin.

During the turbulence, two passengers sustained broken ankles. Both of those passengers had been out of their seats during the turbulence.

What can you do to stay safe?

Almost all in-flight turbulence injuries can be avoided by using common sense.

1. Put your seatbelt on, and keep it fastened when you are seated

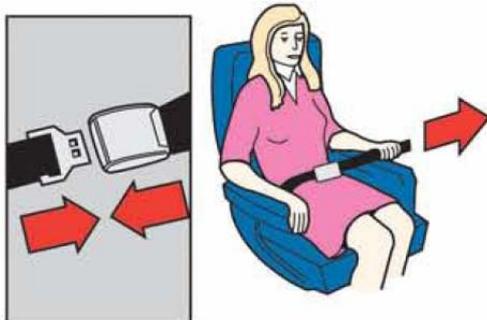
Your seat belt is the best defence against injuries. Keep it fastened low and tight around your waist.

Almost all turbulence injuries involve people who are not properly seated and do not have their seat belt fastened.

When the seat belt sign is on, you are required by law to have your seat belt fastened for your own safety. The pilots or cabin crew will not always have enough time to warn you to put your seat belt on before turbulence hits.

When the seat belt sign is off, you should continue to keep your seat belt fastened. When moving around the cabin to use the restroom facilities and to exercise during long flights, hold on to the seat backs as you walk. This will help secure you if the aircraft moves unexpectedly.

Figure 4: Keep your seat belt fastened when seated



2. Pay attention to the safety demonstration and any instructions given by the cabin crew.

In-flight turbulence injuries are mostly preventable. The safety announcements made by the cabin crew at various stages of the flight about wearing seatbelts when seated are designed to minimise the potential for these injuries to occur. Make sure you follow their instructions at all times.

Safely stow any carry-on baggage in the overhead locker or under the seat in front of you. These items can become projectiles during turbulence if not secured properly.

Figure 5: Follow the instructions of cabin crew

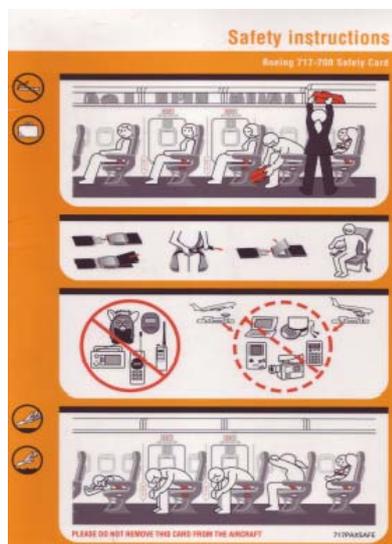


3. Read the safety information card in your seat pocket

A recent ATSB survey of 400 airline passengers found that 65% did not read the safety card at all. This card is provided to all passengers because it contains important safety information specific to the aircraft type you are flying on - you need to read it every time you fly.

Pay particular attention to the brace positions that are right for you and the seat you are sitting in – most people who fly do not know how to brace themselves properly. Bracing your body against the seat in front of you or against your knees will help protect you in severe turbulence.

Figure 6: Read your safety card carefully



How is turbulence being avoided?

Pilots do their best to avoid turbulence by keeping abreast of the latest weather forecasts, and by communicating with other nearby aircraft to check the weather conditions up ahead. Airlines have standard operating procedures in place to ensure all crew members know what to expect and what to do when encountering in-flight turbulence. Cabin crew communicate regularly with the cockpit to ensure that pilots are aware of the conditions in the cabin.

Aircraft interiors are designed to minimise any sharp edges that might cause injuries. In many aircraft, handholds are provided in the cabin, galley and lavatories that can be used by passengers and cabin crew members who are not seated during turbulence.

Tea time turbulence

In 1996, a Boeing 747-200B encountered severe turbulence en route from Cairns to Tokyo, Japan. The aircraft was experiencing smooth flying conditions. Because the turbulence was not detectable by aircraft radar, the crew had no warning and were unable to take any avoiding action.

When the turbulence occurred, the cabin crew were just commencing a meal service. Passengers, cabin crew and meal trolleys hit the cabin ceiling, and then landed heavily back on the floor. Serious injuries were sustained, including bone fractures, lacerations, neck and back strains, a dislocated shoulder and shattered teeth.

In total, 6 cabin crew and 24 passengers sustained injuries. Almost all did not have their seat belts fastened. On arrival at Tokyo, 3 passengers and 1 flight attendant were admitted to hospital.

In these accidents, **injuries** occurred because there was no warning of turbulence - it was **too late** for passengers to **fasten their seat belts** when the turbulence hit.

What are Australian airlines doing?

All major Australian airlines have procedures in place to ensure pilots avoid turbulent conditions wherever possible, and know how to respond if turbulence strikes.

Your cabin crew are trained to ensure passengers are safe at all times, and are aware of the dangers of in-flight turbulence. All cabin crew are first-aid trained to look after passengers who are injured.

It is for this reason that you should follow any requests by cabin crew – including fastening your seat belt, securing carry-on baggage, or returning to your seat when asked.

What about children?

Most major airlines provide child seat belts and bassinets (on larger aircraft) specially-designed for aircraft to ensure children are protected in turbulence. A cabin crew member can arrange these for you.

Parents who choose to bring their own infant seats for their children are individually briefed by a cabin crew member to ensure they know what to do in turbulence. Before you fly, contact the airline at least 24 hours in advance to check that your infant seat is suitable.

An ATSB grant recently funded tests of automotive child restraint systems (CRS) in aircraft. These tests showed that CRS provide much higher levels of safety and protection for children in normal and severe turbulence than a lap belt. Nevertheless, lap belts do provide protection in turbulence, and parents should ensure their children are buckled up even when the seat belt sign is off.

New technology in the cockpit

New ways of detecting turbulence before it strikes are under development. Technologies such as the Turbulence Prediction and Warning System (TPAWS) use airborne sensors to measure changes in the atmosphere that might indicate turbulence up ahead. This information is then displayed to the pilots up to a minute before the aircraft reaches the turbulence, allowing time to climb or descend into calmer air.